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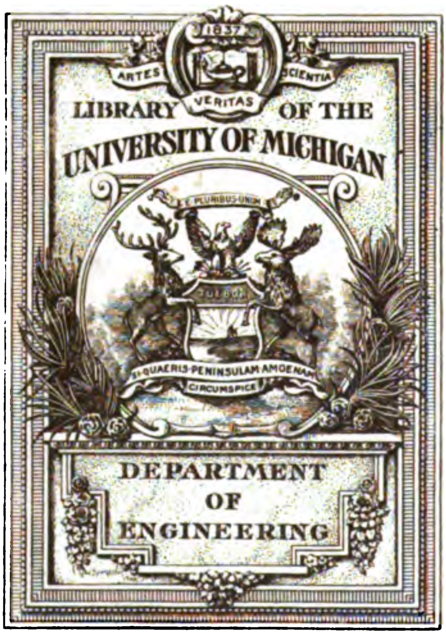

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PROCEEDINGS

OF THE

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PRESIDENT, 1912—1913.

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PROCEEDINGS

OF THE

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS

VOLUME XXXIX. 1912–1913

EDITED BY

THOMAS COLE

ASSOC. M. INST. C.E.

(*Secretary of the Institution*)

The Institution is not as a body responsible for the facts and opinions advanced herein

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ROBERT J. THOMAS, *President.*

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[*Continued on next page*]

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1913–1914.

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South Wales ..	W. Harpur (Cardiff)	G. A. Phillips (Glamorganshire Co.)	H. Alex. Clarke (Briton Ferry)

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1875–6.	*J. G. LYNDE, M. Inst. C.E.
1876–7.	Sir JAMES LEMON, M. Inst. C.E.
1877–8.	*F. ASHMEAD, M. Inst. C.E.
1878–9.	*G. F. DEACON, LL.D., M. Inst. C.E.
1879–80.	*E. PRITCHARD, M. Inst. C.E.
1880–1.	*A. W. MORANT, M. Inst. C.E.
1881– .	*W. S. TILL, M. Inst. C.E.
1882–3.	*C. JONES, M. Inst. C.E.
1883–4.	W. H. WHITE, M. Inst. C.E.
1884–5.	*W. G. LAWS, M. Inst. C.E.
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1886–7.	J. LOBLEY, M. Inst. C.E.
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1888–9.	E. B. ELLICE-CLARK, M. Inst. C.E.
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1908–09.	E. PURNELL HOOLEY, M. Inst. C.E.
1909–10.	W. NISBET BLAIR, M. Inst. C.E.
1910–11.	J. PATON.
1911–12.	A. D. GREATOREX, M. Inst. C.E.
1912–13.	R. J. THOMAS, M. Inst. C.E.

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* *Those Members against whose names a star is placed have passed the examination and hold the Testamur of the Institution.*

R *signifies re-election under By-law* 6. G *elected as Graduate.* A *elected as Associate.* AM *elected as Associate Member.* S *elected as Student.* TA *transferred to Associate.* TAM *transferred to Associate Member.* T *transferred to Member.*

P *signifies recipient of Institution's premium.*

HONORARY MEMBERS.

[Hon.Mem.Inst.M.&Cy.E.]

Date of Election and Transfer.		
1911 Nov. 22	BECHMANN, MONS. G. ..	20 Rue d'Athènes, Paris.
1898 Dec. 17	BICKNELL, R. H., M. Inst. C.E.	Local Government Board, Whitehall, S.W.
1911 Nov. 22	BIENVENUE, MONS. M. F.	48 Rue de Rivoli, Paris.
1913 May 24	BOS, A. W.	Director of Public Works, Amsterdam.
1888 Mar. 3	CODRINGTON, THOS., M. Inst. C.E.	5 Riverdale Rd., Twickenham Park.
1911 Nov. 22	COLMET-DAAGE, MONS.	9 Place de l'Hôtel de Ville, Paris.
1904 Feb. 27	COWAN, P. C., D.Sc., M.Inst. C.E.	Chief Engineering Inspector, Local Government Board, Ireland.
1905 Sept. 23	HAWKSLEY, CHARLES, M. Inst. C.E.	30 Great George Street, S.W.
1913 May 24	LINDO, I. A.	Director of Public Works, The Hague.
1911 Nov. 22	DE PONTICH, MONS. ..	Directeur Administratif des Travaux, Hôtel de Ville, Paris.
1892 Apr. 23	PUTZEYS, MONS. E. . ..	Ingénieur en chef, Directeur de la Ville de Bruxelles.
1890 Sept. 13	ROBINSON, PROFESSOR HY., M. Inst. C.E.	Parliament Mansions, Westminster, S.W.
1874 June 1	TULLOCH, MAJOR H., C.B., R.E.	28 Victoria Street, S.W.
1911 Nov. 22	TUR, MONS. M. P.	9 Place de l'Hôtel de Ville, Paris.
1904 Jan. 23	WILLCOCKS, G. W., C.B., M. Inst. C.E.	Redthorn, Rodway Road, Roehampton.

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MEMBERS.

[M.Inst.M.&Cy.E.].

Date of Election and Transfer.		
1910 May 24	ABBOTT, A. E., A.M.Inst.C.E.	Engineer and Surveyor to the Rural District Council, Stratford and Wolverton.
1913 Sept. 6	ABBOTT, J.	Surveyor to the Urban District Council, Ashborne.
1912 Dec. 7	ABBOTT, O. P.	Engineer and Surveyor to the Urban District Council, Hindley, Lancs.
1893 Oct. 21	ABRAHAMS, C. V.	City Surveyor, Kingston, Jamaica.
1894 June 21 R1902 Mar. 22	ABURROW, C., M. Inst. C.E.	515 Consolidated Buildings, Johannesburg, S.A.
1903 May 16	ADAMS, A. E., M. Inst. C.E.	Borough Engineer, Chippenham, Wilts.
1913 June 21	*ADLARD, F. A.	Chief Assistant, Waterworks Section, Special Works Department, Corporation of Madras.
P1896 Jan. 18	AITKEN, T., M. Inst. C.E. ..	County Surveyor, Cupar, Fife.
A1907 Jan. 19 T1910 Apr. 23	*ALDRIDGE, A. E. W.	Surveyor and Water Engineer to the Urban District Council, Skipton, Yorkshire.
1897 Jan. 16	ALLEN, A. T...	Surveyor to the Urban District Council, Portslade-by-Sea, Sussex.
1911 July 5	ALLISON, A. W.	Burgh Surveyor, Crieff.
1897 June 19	ALVES, G.	Surveyor to the Urban District Council, Glastonbury.
AM1909 Oct. 30 T1911 July 29	*ANDERSON, H. E.	Chief Assistant, Borough Engineer's Office, Lambeth.
1890 June 26	ANDERSON, R. S., Assoc. M. Inst. C.E.	County Surveyor, Peebles.
1900 Dec. 15	ANDERSON, W. V., Assoc. M. Inst. C.E.	City Surveyor, Winchester.
P1906 Apr. 28	ANDREW, J.	County Surveyor's Office, County Bldgs., Dumbarton.
G1898 June 30 T1899 Oct. 21	*ANDREWS, S. P.	Borough Surveyor, Faversham.
G1894 Oct. 20 TP1899 Oct. 21	*ANGEL, R. J., M. Inst. C.E. ..	Borough Surveyor, Bermondsey, S.E.
1894 May 19	*ANGELL, J. A., A.M.Inst.C.E.	Surveyor to the Urban District Council, Beckenham, S.E.
1899 June 29	*ANSTEE, J.	Surveyor to the Rural District Council, Guildford.
1880 May 27 R1899 Feb. 25	ARMISTEAD, R., Assoc. M. Inst. C.E.	10 Booth Street, Bradford.
1912 Dec. 7	ARROWSMITH, R.	Surveyor to the Rural District Council, Stoke-on-Trent, Staffs.
1910 Dec. 10	ASHE, A. V.	Town Surveyor, Urban District Council, Tullamore King's Co., Ireland.

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Date of Election and Transfer.		
AM1910 June 16 T1911 July 29	ASHURST, J.	City Engineer and Surveyor, St. Albans.
1900 June 16	ASQUITH, A.	Surveyor to the Urban District Council, Holyhead.
1890 June 26	ATKINSON, J., A.M. Inst. C.E.	Borough Surveyor, Stockport.
1913 Mar. 15	AUSTEN, H. D.	General Assistant, Borough Engineer's Office, Fulham.
A1908 June 25 TAM1911 July 29 T1912 Feb. 10	*BAGGOTT, S. C.	Borough Engineer, Town Hall, Macclesfield.
AM1909 Jan. 23 T1911 July 29	BAINES, A. C. V.	Resident Engineer, Klipfontein Irrigation Board, P.O. Klipfontein Siding, Cape Province.
1904 Jan. 23	BAINES, C. O.	Surveyor to the Urban District Council, Paignton.
1900 Feb. 10	BAINS, G. S. L.	Town Hall, Guildford, West Australia.
AM1908 Feb. 29 T1911 July 29	BAINS, T. T.	Surveyor to the Rural District Council, South Shields. 1 The Terrace, East Boldon R.S.O., co. Durham.
1913 Mar. 15	BAKER, H. L.	Deputy Borough Surveyor, East Ham.
1891 Aug. 1 R1903 Feb. 21	BAKER, J.	75 High Street, Slough.
1896 June 25	BALDWIN, L. L., A.M. Inst. C.E.	Surveyor to the Urban District Council, Coalville, Leicester.
G1891 Aug. 1 T1896 Feb. 22	*BALL, B., A.M. Inst. C.E. ..	Municipal Engineer's Office, Singapore.
G1887 Sept. 17 T1898 Feb. 19	*BALL, G., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Bexhill.
1913 Apr. 19	BALL, W. J.	Deputy Borough Engineer and Surveyor, Crewe.
A1906 May 26 TAM1909 Dec. 11 T1911 July 29 R1912 Jan. 13	*BALLARD, W. E., A.M. Inst. C.E.	Estville, Southam Road, Hall Green, Birmingham.
1879 Oct. 23	BANKS, W., A.M. Inst. C.E.	City Surveyor, Rochester.
1887 Mar. 12	BARBER, J. PATTEN, M. Inst. C.E. (*Past President. Member of Council.*)	Borough Engineer, Islington, N. *Chairman*, Metropolitan District.
G1901 Aug. 24 T1906 Apr. 28	*BARKER, H. W.	Surveyor to the Urban District Council, Walmer.
1913 Mar. 15	BARKER, J.	Burgh Surveyor, Dumfries.
1910 Oct. 29	BARLOW, E. E.	Borough Engineer, Wisbech.
G1888 Sept. 15 T1892 July 11	*BARNES, S. W. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hanwell.
1897 Jan. 16	BARRETT, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Staines.
1912 July 11	*BARRON, A. Douglas	Deputy Surveyor, Douglas, Isle of Man. 1 Summer Hill, Douglas.
1899 Jan. 21	BARRS, J. D.	Surveyor to the Urban District Council, Bromyard.
G1903 Jan. 17 T1905 May 27	*BATE, E. M.	Surveyor to the Urban District Council, Frinton-on-Sea.

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Date of Election and Transfer.		
A1907 May 25 / TAM1911 July 29 / T1912 Feb. 10	BAXTER, J. G. R.	Deputy Borough Engineer, Gt. Grimsby.
G1901 June 8 / T1903 July 25	*BEACHAM, W. E.	Town Surveyor, Leek.
1903 May 16	BEAN, J. A.	County Surveyor, Northumberland. Moot Hall, Newcastle.
1894 Jan. 13	BEAUMONT, A.	County Surveyor, Yorks, East Riding. County Hall, Beverley.
AM1909 July 17 / T1911 July 29	BEAUMONT, F. G.	Deputy Borough Engineer, Wolverhampton.
1897 Mar. 13	BEAUMONT, G. E.	Surveyor to the Rural District Council, Wortley. "Holme Lea," Greenoside, near Sheffield.
G1906 June 28 / TAM1911 July 29 / T1912 Feb. 10	*BEAUMONT, R. H.	Surveyor to the Urban District Council, Torpoint, R.S.O., Cornwall.
1897 Mar. 13	BEAUMONT, T. C.	Surveyor to the Rural District Council, Driffield.
A1904 Sept. 17 / TAM1911 July 29 / T1912 Feb. 10	BELL, C. D., M.Sc. (Vic.) ..	Surveyor to the Urban District Council, Camborne, Cornwall.
1892 Jan. 16	BELL, G., Assoc. M. Inst. C.E.	Borough Surveyor, Swansea.
A1902 Jan. 25 / T1906 Dec. 15	*BELL, L. M., M.Inst.C.E. ..	Municipal Engineer, Penang, S.S.
1906 Apr. 28	BELL, T. H.	Surveyor to the Urban District Council, Ramsbottom.
A1906 Dec. 15 / TAM1907 Nov. 2 / T1911 July 29	BELSHER, B. J., A.M.Inst.C.E.	Deputy Borough Engineer, 15 Gt. Alie Street, Stepney.
1896 Jan. 18	BENNETT, H. M.	Surveyor to the Rural District Council, Keynsham, Bristol.
1913 Jan. 4	BENNETT, P. S.	Surveyor to the Urban District Council, Ramsey, Hunts.
1912 July 11	BENNETT, W.	Executive Engineer Town Lands Reclamation Works, P.W.D. Rangoon.
G1898 Dec. 17 / T1900 July 19	*BENNETTS, J. P.	Surveyor to the Urban District Council, Harrow.
G1897 July 31 / TA1901 Oct. 19 / TAM1911 July 29 / T1912 Feb. 10	*BENTLEY, J. H., A.M.Inst.C.E.	Deputy Borough Engineer, Town Hall, Oldham.
1886 Oct. 16 / R1896 Jan. 18	BERRINGTON, R. E. W., M. Inst. C.E.	Graisley, Wolverhampton.
G1898 June 30 / TA1901 Oct. 19 / TAM1907 Nov. 2 / T1911 July 29	*BEST, H. STORR, A. M. Inst. C.E.	"Ambleside," Croydon Road, Beckenham.
1892 Mar. 11 / R1899 May 6	BESWICK, W. H., Assoc. M. Inst. C.E.	8 Lowther Street, Whitehaven.
1891 June 6 / R1912 Jan. 13	BETTANY, F.	Green Bank, High Lane, Burslem.
1913 July 16	BEYNON, J. A.	Surveyor to the Rural District Council, Frome, Somerset
1902 Mar. 22	BIBBEY, T.	Cheadle, Staffs.
1890 Mar. 29	BINNIE, SIR A. R., M. Inst. C.E. (*Past President.*)	St. Stephen's House, Victoria Embankment, S.W.

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Date of Election and Transfer.		
G1893 June 24 TA1902 Nov. 8 TAM1908 Sept. 5 T1911 Apr. 29	*BIRCH, J.	Borough Engineer, East Ham, E.
1896 Nov. 28 R1908 Apl. 25	BIRD, W. F.	The Island, Midsomer Norton.
1897 Jan. 16	BIRKS, E.	39 Myddleton Road, Uxbridge.
P1873 May 2 R1909 Oct. 30	BLACKSHAW, W., Assoc. M. Inst. C.E.	Argyle House, Rowley Park, Stafford.
1910 May 24	BLACKWALL, J. E., A.M.Inst. C.E.	County Surveyor, Cambridgeshire. 61 Sidney Street, Cambridge.
1904 Aug. 5	BLACKWOOD, R.	Burgh Surveyor, Kilmarnock.
1886 June 12	BLAIR, W. N., M.Inst. C.E. (*Past President. Member of Council.*)	Borough Surveyor, St. Pancras.
G1901 Aug. 24 TA1908 Sept. 5 TAM1911 July 29 T1911 Sept. 23	*BLANCHARD, R.	Surveyor to the Urban District Council, Cannock, Staffs.
1903 Oct. 17	BLAND, J. D.	Engineering Assistant, Borough Surveyor's Office, Cambridge.
1907 Apr. 27	BLANEY, C.	Borough Surveyor, Newry, Ireland.
1913 Apr. 19	BLEWITT, H.	Engineer and Surveyor to the Rural District Council, Mutford and Lothingland.
1900 Mar. 10	BLOOD, A. T.	Surveyor to the Urban District Council, Hitchin.
1907 May 25	BODDIE, C. L., A.M.Inst.C.E.	County Surveyor, Londonderry.
AM1910 Mar. 12 T1911 July 29	BOLTON, E. E. T.	Engineer to the Urban District Council, Woodhall Spa.
1902 Nov. 8	*BORG, E. A.	Borough Surveyor, Margate.
1904 Feb. 27	BOTTOMLEY, H.	Surveyor to the Urban District Council, Bingley.
1913 Mar. 15	BOTTOMLEY, H. L.	Assistant Borough Engineer, Brighouse.
1877 May 1	BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	7 Victoria Street, S.W.
1898 Mar. 19 R1903 Feb. 21	BOWEN, H. W.	County Surveyor, West Sussex County Council, Horsham. *Hon. Sec.*, South Eastern District.
AM1909 Jan. 23 T1911 July 29	BOWES, T.	County Surveyor's Office, Hatfield, Herts.
1898 Oct. 15	BOYLE, J. C.	City Surveyor, Armagh.
1903 May 16	BRADLEY, A. W., M.Inst.C.E.	Borough Engineer, St. Helens, Lancs. *Hon. Sec.*, North Western District.
G1905 Jan. 28 A1907 Mar. 2 T1910 Sept. 17	*BRADLEY, C. G.	Engineer and Surveyor to the Urban District Council, Goole.
1897 Jan. 16	BRADLEY, W. L.	Surveyor to the Urban District Council, Tonbridge.
1911 Sept. 23	BRADSHAW, A. G.	Borough Surveyor and Water Engineer, Lancaster.
G1899 June 10 TA1905 Jan. 28 TAM1908 Dec. 5 T1911 July 29	*BRADSHAW, A. S., A.M. Inst. C.E.	Engineer, P. W. D., Freetown, Sierra Leone.

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Date of Election and Transfer.		
1891 Aug. 1	BRETT, J. H.	County Surveyor, Co. Antrim. Belfast, Ireland.
1891 Aug. 1	BRETTELL, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
1894 Oct. 20	BRIDGES, O. A.	Surveyor to the Urban District Council, Bognor.
AM1911 June 10 T1911 July 29	BRIDGEWATER, A. T.	Borough Engineer's Office, East Ham, E.
1891 Mar. 21	BRIERLEY, J. H., A. M. Inst. C.E.	Borough Surveyor, Richmond, Surrey.
1912 Dec. 7	BRINDLE, W. F.	Engineer and Surveyor, Rural District Council, Twrcelyn, Anglesey.
1912 Dec. 7	BRINDLEY, L. K.	Chief Engineering Assistant, Public Works Department, Zanzibar.
G1898 June 30 TA1903 June 25 TAM1911 July 29 T1912 Feb. 10	*BRISCOE, J. T.	Deputy Engineer, Council Offices, Enfield.
1913 Jan. 4	BRITTON, F.	Highway Surveyor, Rural District Council, Dore. Pontrilas, Hereford.
1901 Dec. 7	BRODIE, J. A., M. Eng., Wh. Sc., M. Inst. C.E. (*Past President. Member of Council.*)	City Engineer, Liverpool.
P1889 Apr. 13	BRODIE, J. S., M. Inst. C.E.. (*Member of Council.*)	Borough Engineer, Blackpool. *Chairman*, North Western District.
1894 Oct. 20	BROOKE, J.	Surveyor to the Urban District Council, Northwich, Cheshire.
A1902 Jan. 25 T1908 Sept. 5	BROOKES, A. E.	County Surveyor, Cornwall. Truro.
1910 July 16	BROOKS, E. J. D.	Chief Engineer to the Transkeran and Ponderland General Councils, General Council Offices, Umtata, Cape Colony
1884 July 10	BROWN, A., M. Inst. C.E. ..	City Engineer, Nottingham.
1898 Jan. 15	BROWN, C., A.M. Inst. C.E..	Engineer to the Urban District Council, Town Hall, Edmonton.
1904 Aug. 25	BROWN, CHAS.	Burgh Surveyor, Hawick.
1913 Apr. 19	BROWN, C. C.	Resident Engineer, Port Said Drainage, Port Said.
AM1911 Jan. 21 T1911 July 29	*BROWN, C. F...	Surveyor to the Urban District Council, Leiston, Suffolk.
AM1910 May 24 T1911 July 29	*BROWN, D. J...	Engineering Assistant, P.W.D., Hong Kong.
A1902 Jan. 25 T1910 Jan. 22	BROWN, H. A.	Engineer to the Urban District Council, Weston-super-Mare.
1908 Jan. 18	BROWN, H. E.	Surveyor to the Urban District Council, Altrincham.
1905 Sept. 23	BROWN, H. H. Lane, M. Inst. C.E.	Supervising Engineer, Lucknow, United Provinces, India.
G1894 July 7 T1898 Sept. 3	*BROWN, Reginald, M. Inst. C.E.	Surveyor to the Urban District Council, Town Hall, Southall Norwood. 21 Old Queen Street, Westminster.

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Date of Election and Transfer.		
A1910 Apr. 23 TAM1911 July 29 T1912 Feb. 10	BROWN, R. D., A.M.Inst.C.E.	Dept. of Railways and Canals, Welland Ship Canal Office, St. Catharines, Ontario, Canada.
1893 Mar. 4	*BROWNRIDGE, C., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Birkenhead. *District Representative*, North Western District.
1904 Aug. 9	BRUCE, J. S.	Burgh Surveyor, Kirriemuir.
1873 Feb. 15	BRYAN, W. B., M. Inst. C.E.	Chief Engineer, Metropolitan Water Board, Savoy Court, W.C. Elmstead Wood, Elmstead Lane, Chislehurst.
1901 Feb. 16	BRYCE, J., M. Inst. C.E. (*Vice-President Scotland. Member of Council.*)	Public Works Office, City Chambers, Glasgow.
G1889 Feb. 9 T1902 Mar. 22	*BRYNING, W. G.	County Surveyor, Yorks, North Riding. Northallerton.
1873 May 2	BUCKHAM, E., M. Inst. C.E.	Consulting Engineer to the Corporation, Town Hall, Ipswich.
1912 Dec. 7	BUCKLEY, D. J.	Surveyor to the Fermoy and Mallow Urban District Council. 53 South Mall, Cork.
1897 July 8 R1902 Mar. 22	BUCKLEY, M. J., Assoc. M. Inst. C.E.	Garrán an Cheoil, Iona Drive, Dublin.
1911 Apr. 29	BUCKLEY, R. H.	Borough Engineer, Mossley.
1913 Feb. 8	*BUDGETT, W. H.	Assistant Engineer and Surveyor, Urban District Council, Wood Green.
1897 Feb. 13	BULL, H. F., A.M. Inst. C.E.	County Surveyor, Cheshire.
A1908 Feb. 29 TAM1910 May 24 T1911 July 29	*BULLOUGH, J. S., A.M.Inst. C.E.	Deputy Borough Engineer, Preston.
1895 Feb. 16	BUNTING, T. F.	Borough Surveyor, Maidstone.
1913 Jan. 4	BURCH, F. L.	Engineer and Surveyor, Urban District Council, East Dereham, Norfolk.
1895 Jan. 19	BURDEN, A. M., B.E., Assoc. M. Inst. C.E.	County Surveyor, Kilkenny
1892 Sept. 24	BURGESS, S. E., M. Inst. C.E.	Borough Engineer, Middlesbrough.
1900 Apr. 21	BURKITT, J. P., B.E., A.M. Inst. C.E.	County Surveyor, Enniskillen.
1905 Mar. 3	BURN, W., A. M. Inst. C.E...	Surveyor to the Urban District Council, Sutton-in-Ashfield, Notts.
1904 Aug. 6	BURNS, D.	Burgh Surveyor, Pollokshaws.
1910 Oct. 29	BURROWS, T...	Surveyor to Lathom and Burscough Urban District Council. Lathom, near Ormskirk.
1890 June 7 R1912 Apr. 27	BURSLAM, R.	18 Moody Street, Congleton.
G1895 Jan. 19 T1902 Jan. 25	*BURTON, A., A.M. Inst. C.E.	Borough Engineer, Stoke-on-Trent.
1913 Feb. 8	BURTON, R. W.	Highway Surveyor, Rural District Council, Dunmow.
A1904 May 28 TAM1909 Apr. 24 T1911 July 29	*BURTON, W. E. H., A.M. Inst. C.E.	Engineer to the West Riding Asylums Board, Wakefield.

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Date of Election and Transfer.		
1897 Jan. 16	BUSBRIDGE, T. A.	Surveyor to the Rural District Council, Maidstone. Bower Mount Road, Maidstone.
G1899 June 29 TA1902 Jan. 25 T1904 Feb. 27	*BUSH, W. E., A. M. Inst. C.E.	City Engineer, Auckland, New Zealand.
1890 Sept. 13	BUTLER, W.	Surveyor to the Urban District Council, Fareham.
1899 June 29	BUTTERWORTH, A. S., Assoc. M. Inst. C. E.	Municipal Engineer, Port Elizabeth, S. Africa.
G1905 Dec. 9 T1907 Apr. 27	*BUTTERWORTH, G. L.	Surveyor to the Rural District Council, Isle of Thanet.
1913 Apr. 19	CAHILL, P.	Engineer and Surveyor to the Rural District Council, Dundalk and Ardee.
1894 Apr. 6	CAINE, T., Assoc.M.Inst. C.E.	City Engineer, Worcester.
1913 May 24	CAINE, T. G.	Borough Engineer, King Williamstown, South Africa.
1903 Jan. 17	CALDER, W., A. M. Inst. C.E.	Chairman of the Country Roads Board, Titles Office, Melbourne.
1913 Jan. 4	CALLAWAY, A. W.	Surveyor to the Urban District Council, Nailsworth, Glos.
1912 June 1	CALVERT, G	County Road Surveyor, Maud, Aberdeenshire.
1891 Oct. 17	CAMPBELL, A. H., M. Inst. C.E. (*Member of Council.*)	City Engineer, Edinburgh. *District Representative*, Scottish District.
1887 Mar. 12	CAMPBELL, K. F., M. Inst. C.E.	Borough Engineer, Huddersfield.
G1906 June 28 T1911 June 10	*CAPLEN, L.	Surveyor to the Rural District Council, Yeovil, Montacute S.O., Somerset.
1888 May 12	CAPON, E. R.	Surveyor to the Urban District Council, Epsom.
1890 Oct. 18 R1899 Jan. 21	CARD, H...	10 North Street, Lewes.
AM1908 Feb. 29 T1909 Oct. 30	CAREY, J. G.	Surveyor to the Urban District Council, Heston and Isleworth. Council House, Hounslow.
1910 Oct. 29	CARR, W. L.	Engineer and Surveyor to the Urban District Council, Ruislip-Northwood.
1903 Feb. 21	CARTER, A. H.	Surveyor to the Urban District Council, Litherland, Liverpool.
A1904 May 28 TAM1908 Dec. 5 T1911 July 29	CARTER, E. W. A...	Deputy City Surveyor, Gloucester.
1901 June 27	CARTER, G. E.	Surveyor to the Rural District Council, Winchester.
1897 June 19	CARTER, G. F.	Surveyor to the Urban District Council, Mexborough.
G1892 July 11 TA1901 Dec. 7 T1904 Jan. 23	*CARTER, G. F., M.Inst.C.E... (*Member of Council.*)	Borough Engineer, Croydon.

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Date of Election and Transfer.		
G1903 Dec. 12 TA1907 Mar. 2 TAM1909 June 5 T1911 July 29	*CARTER, S. F. B., A.M.Inst. C.E.	Deputy Engineer, Council House, Hounslow.
1898 Dec. 17	CARTWRIGHT, A. S.	Surveyor to the Urban District Council, Wilmslow, Cheshire.
1873 May 2	CARTWRIGHT, J., M. Inst. C.E. (*Past President.*)	21 Parsons Lane, Bury.
1904 June 26	CARVER, W.	Surveyor to the Rural District Council, Melford. 3 Melford Road, Sudbury, Suffolk.
1895 Mar. 16	CASS, R. W.	Surveyor to the Urban District Council, Farnham, Surrey.
G1890 Sept. 13 TA1902 Sept. 6 TAM1909 Mar. 27 T1911 July 29	*CATCHPOLE, J. H.	Deputy Engineer and Surveyor, Council Offices, Finchley, N.
1912 Oct. 26	CATTANACH, D.	County Road Surveyor, Tobermory, Argylshire.
1895 Mar. 16 R1899 Feb. 25	CATT, A. J.	Alston House, Southwick, Sussex.
G1904 May 29 TA1907 May 25 TAM1908 May 23 T1911 July 29	*CATTLIN, O., A. M. Inst. C.E.	Assistant Borough Engineer, Holborn.
1896 Mar. 21	CHADWICK, J...	Surveyor to the Urban District Council, Fenny Stratford.
1903 Jan. 17	CHAMBERS, S. H.	Surveyor to the Urban District Council, Hampton.
1901 Dec. 7	CHANCELLOR, W. B.	City Surveyor, Lichfield.
1897 Jan. 16	CHAPMAN, C. R. W.	Surveyor to the Urban District Council, Wembley.
1910 Apr. 23	CHAPMAN, H. T.	County Surveyor, Somerset. Wells. *Chairman*, South-Western District.
1912 Apl. 27	CHAPMAN, W. A.	County Road Surveyor, Lanarkshire County Council. Airdrie.
1893 Mar. 4 R1899 May 6	CHARLES, T.	The "Laurels," 26 Gayton Road, Harrow-on-the-Hill.
AM1907 Sept. 7 T1911 July 29	*CHART, R.	Highway Surveyor to the Rural District Council, Croydon. Council Offices, Katharine Street, Croydon.
1884 Dec. 20	CHART, R. M.	Surveyor to the Rural District Council, Croydon. Town Hall, Croydon.
1909 Oct. 30	CHESNEY, S.	Surveyor to the Urban District Council, Featherstone, Yorks.
1912 Apl. 27	CHIVERS, H. J.	Surveyor to the Urban District Council, Fleet.
1900 Feb. 10	CHOWINS, W. H.	Surveyor to the Urban District Council, Burnham, Somerset.
AM1909 July 17 T1911 July 29	CHRISTIE, A. K.	Engineering Assistant, City Road Surveyor's Office, Edinburgh.
1912 Sept. 9	CHURCHILL, A. F...	First Assistant to Director of Public Works, Hong Kong.

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Date of Election and Transfer.		
1911 July 5	CHURCHWARD, S. F. C.	Surveyor and Water Engineer to the Urban District Council, Dawlish.
1884 Oct. 9 R1907 June 20	CLARE, J., A.M. Inst. C.E...	Surveyor, Sleaford.
AM1909 Feb. 27 T1911 July 29	CLARE, S. F.	Surveyor to the Urban District Council, Sleaford.
A1908 Feb. 29 TAM1910 Jan. 22 T1911 July 29	*CLARE, T. A.	Deputy Borough Surveyor, Leigh, Lancs.
1908 Jan. 18	CLARK, W. G. J.	Surveyor to the Urban District Council, Wigston Magna, Leicester.
1898 Sept. 3	CLARKE, E. O'N.	County Surveyor, Leitrim.
A1902 May 10 T1904 Apr. 30	CLARKE, G. E., A.M.Inst.C.E.	Borough Surveyor, Boston, Lincolnshire.
1899 Oct. 21	CLARKE, H. Alex...	Surveyor to the Urban District Council, Briton Ferry. *Hon. Secretary*, South Wales District.
1898 Oct. 15	CLARRY, W. A. H., A.M.Inst. C.E.	Borough Surveyor, Sutton Coldfield.
1886 Dec. 18	CLARSON, H. J.	Surveyor to the Rural District Council, Tamworth.
G1894 July 7 TA1904 Sept. 17 TAM1911 July 29 T1912 Feb. 10	*CLAYPOOLE, A. H., A.M.Inst. C.E.	Divisional Engineer, City Engineer's Department, Bristol.
1913 Feb. 8	CLAYTON, A. H.	County Road Surveyor, Aboyne, Aberdeenshire.
1901 May 11	CLAYTON, F T.	Borough Engineer, Reigate.
G1894 July 7 T1908 Oct. 24	*CLEGG, H., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Felixstowe.
AM1909 Feb. 27 T1911 July 29	CLEGG, W. A.	Surveyor to the Urban District Council, Dorking.
G1898 Dec. 17 TA1902 Mar. 22 TAM1908 Apr. 25 T1911 July 29	*CLEWS, C. A.	Deputy Borough Surveyor, Derby.
1893 July 31	CLOUGH, W.	Surveyor to the Urban District Council, Audenshaw.
1899 Oct. 21	CLUCAS, R. H.	Borough Surveyor, Kingston-on-Thames.
G1894 July 7 T1896 Oct. 24	*COALES, H. F., A.M. Inst. C.E.	Surveyor to the Urban District Council, Sunbury-on-Thames.
G1886 Oct. 16 T1888 July 12	*COALES, H. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Market Harborough.
1882 Sept. 30	COCKRILL, J. W., M. Inst. C.E. (*President.*)	Borough Surveyor, Great Yarmouth.
1893 June 24	COCKRILL, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Biggleswade, Beds.
1913 Mar. 15	COLE, R. E.	Deputy Borough Surveyor, Darlington.
1904 June 26	COLEBY, H. J.	Surveyor to the Rural District Council, Atherstone, Warwickshire.
1892 Sept. 24	COLLEN, W., M.A., M.Inst.C.E.	County Surveyor, Dublin. *Chairman*, Irish District.

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Date of Election and Transfer.		
G1899 June 29 TA1902 Jan. 25 TAM1907 Dec. 14 T1909 Apr. 24	*Collinge, T. P., A.M. Inst. C.E.	Borough Engineer and Surveyor, Mansfield.
1888 May 12	COLLINS, A. E., M.Inst.C.E. (*Past President. Member of Council.*)	City Engineer, Norwich.
A1905 May 27 TAM1907 Sept. 7 T1911 July 29	Collins, H., A. M. Inst. C.E.	Deputy City Engineer, Norwich.
1896 Jan. 18	Collins, R.	Surveyor to the Urban District Council, Enfield, N.
1905 Apr. 29	Collins, W. A.	Surveyor to the Rural District Council, Bridgwater.
G1897 Feb. 13 TA1901 Oct. 19 TAM1908 Apr. 25 T1911 July 29	*Collis-Adamson, A. C. ..	Assistant Borough Engineer, Hornsey, N. Municipal Offices, Highgate.
G1897 July 31 T1900 Dec. 15	*Cook, F. C., A.M. Inst. C.E.	Borough Surveyor, Nuneaton. *Hon. Sec.*, West Midland District.
1893 Apr. 22	Cook, F. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mansfield Woodhouse.
G1888 July 12 T1890 Mar. 29	*Cook, J., Assoc. M. Inst. C.E.	Engineer to the Fylde Water Board, Blackpool.
A1903 May 16 TAM1911 July 29 T1912 Feb. 10	Cooke, J. E...	Assistant Borough Engineer, Town Hall, Islington, N.
1898 Sept. 3	Cooper, E. C.	Surveyor to the Urban District Council, Shanklin, Isle of Wight.
1894 Oct. 20	Cooper, F. A., C.M.G., M. Inst. C.E.	Director of Public Works, Colombo, Ceylon.
1887 Sept. 17	Cooper, W. W.	Surveyor to the Urban District Council, Slough.
1893 Apr. 22 R1902 Nov. 8	Copley, C. T., A.M.Inst.C.E.	252 Barkerhouse Road, Nelson, Lancashire.
1896 Jan. 18	Cordon, R. C.	Surveyor to the Rural District Council, Belper. "Belmont," Duffield, near Derby.
1913 Apr. 19	Cordon, R. Curtis	Surveyor to the Rural District Council, Hereford. 11 Grenfell Road, Hereford.
G1896 May 29 T1897 June 19	*Corrie, H. W.	Surveyor to the Urban District Council, Lower Bebington, Cheshire.
1894 June 21 R1903 Jan. 17	Cotterell, A. P. I., M.Inst. C.E.	28 Baldwin Street, Bristol; and 17 Old Queen Street, S.W.
1906 Mar. 3	Cottle, F.	Borough Engineer, Douglas, Isle of Man.
1913 May 24	Coughlan, P.	Engineer to the Rural District Council, Michelstown. King Street, Michelstown, Ireland.
AM1910 July 16 T1911 July 29	Coupe, A. E...	Surveyor to the Urban District Council, Fulwood, Lancs.

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Date of Election and Transfer.		
A1907 Sept. 7 TAM1911 July 29 T1912 Mar. 2	COURT, W. H. A., A.M.Inst. C.E.	Borough Surveyor's Office, Leicester.
G1899 Oct. 21 TA1902 Nov. 8 TAM1911 July 29 T1912 Feb. 10	*COWAN, G.	District Surveyor, Town Hall, Portsmouth.
A1905 Mar. 4 T1911 Jan. 21	*COX, C. L., A.M.Inst.C.E. ..	City Sanitation Engineer, Colombo, Ceylon.
P1880 Feb. 7 B1911 Apr. 29	COX, J. H., M. Inst. C.E. ..	The Cottage, Clayton, Bradford.
AM1910 Mar. 12 T1911 July 29	COZENS, L. A.	Surveyor of Highways to the Isle of Wight Rural District Council. "Walmer Villa," Castle Road, Newport.
G1906 Jan. 20 A1907 Mar. 2 T1911 Jan. 21	*CRABB, H. R., A.M.Inst.C.E.	Borough Surveyor, Municipal Offices, Pembroke Dock.
1900 Mar. 10	CRABTREE, W. R., M.Sc.(Vict.), A. M. Inst. C.E.	Surveyor to the Rural District Council, Doncaster.
1911 June 10	CRAWSHAW, J. S.	Surveyor to the Urban District Council, Weybridge.
P1881 May 6	CREER, A., Assoc. M. Inst.C.E.	Engineer to the Ouse and Foss Navigations. 1 Low Ousegate, York.
A1902 Jan. 25 TAM1907 Dec. 14 T1911 July 29	CROOKE, W. E. FROOME ..	Chief Engineering Assistant, Middlesex County Council. 19 West Park Road, Kew Gardens.
AM1908 Oct. 24 T1911 July 29	CROOME, R.	Surveyor to the Urban District Council, Cromer.
G1905 June 22 A1906 Nov. 3 TAM1910 Jan. 22 T1911 July 29	*CROSS, W. G., A.M. Inst. C.E.	Assistant Borough Surveyor, Town Hall, Richmond, Surrey.
1889 Dec. 14	*CROWTHER, J. A., Assoc. M. Inst. C.E.	Borough Engineer, Southampton.
A1901 Oct. 19 T1910 Oct. 29	*CROXFORD, C. H.	Engineer and Surveyor to the Urban District Council, Wood Green.
G1907 May 25 T1908 July 18	*CROXFORD, J. W...	Surveyor to the Urban District Council, Brentford.
G1900 Jan. 19 T1903 May 16	*CRUMP, E. H., A. M. Inst. C.E.	Surveyor to the Urban District Council, Hinckley.
G1898 June 30 T1904 Apr. 30	*CUDBIRD, T. O.	Shire Engineer, Gundurimba. Shire Offices, Lismore, N.S.W.
AM1907 Dec. 14 T1911 July 29	CULLIN, H. B.	Surveyor to the Rural District Council, Isle of Wight.
1889 Dec. 14	CURRALL, A. E.	Surveyor to the Rural District Council, Solihull, Warwickshire.
1893 Mar. 4 B1899 Feb. 25	CURRY, W. T., A.M. Inst. C.E.	Minas de Rio Tinto, Provincia de Huelva, Spain.
1897 Feb. 13	CUTLER, H. A., M. Inst. C.E. (*Vice-President, Ireland. Member of Council.*)	City Surveyor, Belfast.

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Date of Election and Transfer.		
1913 Feb. 8	DALLOW, G. H.	Engineer and Surveyor to the Rural District Council, Halesowen. Public Offices, Great Cornbow, Halesowen.
1893 June 24	*DALTON, J. P.	Surveyor to the Urban District Council, Ryton-on-Tyne.
G1905 Jan. 28 TAM1909 Mar. 27 T1911 July 29	*DARBY, A. E., A.M. Inst. C.E.	Borough Engineer and Surveyor, Town Hall, Bethnal Green, N.E.
1912 Jan. 13	DASHPER, L. G.	Surveyor to the Urban District Council, Sandown Isle of Wight.
1899 Jan. 21	DAVIDSON, J. F.	P.O. Nairobi, British East Africa.
1900 Oct. 15	DAVIES, W. J.	Surveyor to the Urban District Council, Nantyglo and Blaina. Council Offices, Blaina.
1880 Apr. 10	DAVIS, A. T., M. Inst. C.E. (*Past President.*)	County Surveyor, Salop. Shrewsbury. *Chairman* and *District Representative*, West Midland District.
AM1911 July 5 T1911 July 29	DAVSON, S. S.	Ministry of Public Works, Cairo Tanzim Dept. Road Service, Cairo.
1900 Oct. 15	*DAWSON, C. F.	Surveyor to the Urban District Council, Barking.
1884 Apr. 19 R1902 Nov. 8	DAWSON, C. J.	Wykeham House, Barking.
1898 Jan. 15	DAY, C.	Borough Surveyor, Chatham.
1898 Jan. 15	DEANE, J. W...	Surveyor to the Urban District Council, Smallthorne.
1892 Mar. 11	*DEARDEN, H., A. M. Inst. C.E.	Borough Engineer, Dewsbury.
1904 July 14	DELANY, J. F.	City Engineer, Cork.
P1890 Feb. 1	DENNIS, N. F., M. Inst. C.E.	Borough Engineer, West Hartlepool.
AM1908 July 18 T1911 July 29	DENTON, A. J.	Borough Surveyor's Office, South Shields.
1896 July 25	DEWHIRST, J...	Surveyor to the Rural District Council, Chelmsford.
G1898 Oct. 15 T1899 June 10	*DICKINSON, A. J.	Surveyor to the Urban District Council, Redditch.
1895 June 27	DICKINSON, R.	Surveyor to the Urban District Council, Berwick-on-Tweed.
1881 Dec. 10	DIGGLE, J., A.M. Inst. C.E.	Water Engineer, Heywood.
1910 Jan. 22	DIGGLE, J. S., A. M. Inst. C.E.	Water Engineer, "Oakhurst," Heywood.
1897 Apr. 10	DIVER, D. J.	Surveyor to the Urban District Council, Marple, near Stockport.
1913 Apr. 19	DIXON, A. E.	Highway Surveyor, Municipal Buildings, Southampton.
1897 Jan. 16 R1903 Jan. 17	DIXON, F. J., A.M. Inst. C.E.	Town Hall Chambers, Ashton-under-Lyne.

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Date of Election and Transfer.		
G1891 Aug. 1 T1896 Oct. 24	*DIXON, J. R. M. Inst. C.E.	Borough Engineer, Town Hall, Woolwich.
1887 June 18	DIXON, R.	Borough Surveyor, Stratford-on-Avon.
1912 Jan. 13	DIXON, W.	Engineering Assistant, Municipal Buildings, Leeds.
1889 July 4	DODD, P., M. Inst. C.E. ..	Borough Engineer, Wandsworth. 215 Balham High Road, S.W.
1897 Jan. 16	*DODGKON, A., A.M. Inst. C.E.	Surveyor to the Urban District Council, Clayton-le-Moors.
G1891 Sept. 12 TA1902 Sept. 6 TAM1907 Dec. 14 T1911 July 29	*DOLAMORE, F. P.	Deputy Borough Engineer, Bournemouth.
1909 Sept. 4	DONALD, D. A.	Burgh Surveyor, Grangemouth.
1888 May 12	DORMAN, R. H., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Armagh. *District Representative*, Irish District.
1898 June 30	DORMER, P. C.	Surveyor to the Urban District Council, Chesham, Bucks.
G1903 June 25 T1904 Sept. 17	*DOUGLAS, S.	Surveyor to the Urban District Council, Kenilworth.
1906 Jan. 20	DOUGLASS, W. L., M.Inst.C.E.	District Engineer, Middle Ward, Lanark County. District Offices, Hamilton.
1912 July 11	DRAKE, S. R.	Engineer and Surveyor to the Urban District Council, Leatherhead.
G1904 May 28 TA1908 Sept. 5 TAM1911 July 29 T1912 Feb. 10	*DRAPER, J., A.M.Inst.C.E. ..	Surveyor to the Urban District Council, Council Offices, Saltburn-by-the-Sea.
A1906 June 28 TAM1909 June 5 T1911 July 29	*DRESDEN, W. J.	Engineer's Office, Town Hall, Battersea.
A1909 Feb. 27 T1910 Oct. 29	DREW, J. H.	Engineer and Surveyor, Urban District Council, Wath-upon-Dearne.
1913 Mar. 15	DRIVER, H. M.	Surveyor to the Rural District Council, Tadcaster. Garforth, near Leeds.
1913 Mar. 15	DRUMMOND, R.	County Road Surveyor, Renfrewshire County Council. Fairfield, Paisley.
1899 Oct. 21	DRYLAND, A., M.Inst. C.E. ..	County Surveyor, Surrey. Kingston-on-Thames. *Chairman*, South-Eastern District.
1891 Dec. 12	DUFFIN, W. E. L., M. Inst. C.E. I.	County Surveyor, Waterford, Ireland.
1900 Dec. 15 R1901 June 8	DUNCH, T. H.	27 Clement's Lane, Lombard Street, E.C.
1898 May 21	DUNN, J...	Surveyor to the Rural District Council, Chesterton. Brunswick House, Cambridge.
A1907 Jan. 19 TAM1910 July 16 T1911 July 29	*DUNNING, W. J.	Assistant Surveyor, Urban District Council, Colwyn Bay.

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Date of Election and Transfer.		
1873 Feb. 15	DUNSCOMBE, C., M.A., M. Inst. C.E.	92 Victoria Street, Westminster S.W.
G1891 Jan. 21 T1892 Sept. 24	*DYACK, W., M. Inst. C.E. ..	Burgh Surveyor, Aberdeen.
G1899 June 29 TA1905 June 22 TAM1909 June 5 T1911 July 29	*DYER, R. H.	Deputy Borough Engineer, Southend.
1882 June 29	DYER, S...	Engineer to the Rural District Council, Bridlington. 29 Quay Road, Bridlington.
1879 May 1	EARNSHAW, J. T., Assoc. M. Inst. C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
1904 Aug. 3 B1909 Oct. 30	EASTON, W. C., B. Sc., M. Inst. C.E.	14 Blythswood Square, Glasgow.
1883 Aug. 4	EATON-SHORE, G., Assoc. M. Inst. C.E.	Borough Surveyor, Crewe.
1890 Feb. 1	EDDOWES, W. C.	Borough Surveyor, Shrewsbury.
1913 Mar. 15	EDEY, J...	Surveyor to the Urban District Council, St. Neots.
1910 June 16	EDWARDS, D., A.M.Inst.C.E.	Borough Engineer, Taunton. *Hon. Sec.*, South Western District.
G1907 Sept. 7 TAM1911 July 29 T1912 Feb. 10	*EDWARDS, E. W.	Surveyor to the Urban District Council, Blaenavon, Mon.
1911 Dec. 2	EDWARDS, E. Watkin	Engineer and Surveyor to the Urban District Council, Mynyddislwyn, Council Offices, Pontllanfraith, Mon.
1904 Jan. 23	EDWARDS, H. C. J., Assoc. M. Inst. C.E.	Borough Engineer, Lambeth.
G1906 Dec. 15 TAM1909 Mar. 27 T1911 July 29	*EDWARDS, J. H.	Chief Assistant, Engineer's Office, Rural District Council, Wrexham.
1907 Nov. 2	ELCE, W. H., A. M. Inst. C.E.	Borough Engineer, Bacup.
1911 Jan. 21	*ELEY, W. H...	Engineer and Surveyor, Urban District Council, Town Hall, Newmarket.
1897 July 31	*ELFORD, E. J. (*Member of Council.*)	Borough Surveyor, Southend-on-Sea. *District Representative* Eastern District.
1873 Feb. 15	ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President.*)	13 Charles Street, St. James's, London, S.W.
G1898 Dec. 17 TA1901 Dec. 7 TAM1911 July 29 T1912 Feb. 10	*ELLISON, D., A.M.Inst.C.E...	Deputy Borough Engineer, West Bromwich.
G1898 Feb. 19 TA1902 Jan. 25 TAM1911 July 29 T1912 Feb. 10	*ENDSOR, H. A.	Surveyor to the Rural District Council, Keynsham, Bristol.

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Date of Election and Transfer.		
1907 May 25	ENGLAND, J.	Borough Engineer, Wrexham. *Hon. Sec.*, North Wales District.
1912 Dec. 7	ENNOR, J.	Engineer and Surveyor, Urban District Council, Newquay, Cornwall.
1895 July 27	ENTWISLE, H.	Surveyor to the Urban District Council, Swinton, near Manchester.
G1898 Dec. 17 TAM1909 Dec. 11 TP1911 Jan. 21	*ESSEX, E. H., A.M.Inst.C.E.	Engineer and Surveyor, Urban District Council, Leyton, Essex
1897 Jan. 16	EVANS, E., A. M. Inst. C.E. (*Member of Council.*)	County Surveyor, Carnarvonshire. *District Representative*, North Wales District.
1895 Jan. 19	EVANS, E. I., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Penarth, S. Wales.
1896 May 29	EVANS, J. P.	Surveyor to the Rural District Council, Wrexham. *Chairman*, North Wales District.
1903 Oct. 17	EVANS, S.	County Surveyor, Mold, Flintshire.
1913 Feb. 8	EYRE, W.	Surveyor to the Urban District Council, Yeardesly-cum-Whaley.
1890 June 7	FAIRLEY, W., M. Inst. C.E.	Richmond Main Sewerage Board, Kew Gardens, S.W., and Parliament Mansions, Victoria Street, S.W.
G1898 June 30 T1899 Feb. 25	*FARNHAM, W. A.	Surveyor to the Urban District Council, Foot's Cray. Sidcup.
AM1908 Dec. 5 T1910 Dec. 10	FARMER, H. J.	Borough Surveyor, Christchurch, Hants.
1893 July 31	FARRINGTON, T. B., A. M. Inst. C.E.	Surveyor to the Rural District Council, Conway. Trinity Square, Llandudno.
1896 Jan. 18	FARRINGTON, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Woodford Green, Essex.
1900 Dec. 15	*FELLOWS, T. E.	Surveyor to the Urban District Council, Willenhall.
1894 Jan. 13	FENN, T...	Surveyor to the Urban District Council, Belper.
AM1909 Dec. 11 T1911 July 29	FENTON, H.	Surveyor to the Urban District Council, Thornton, Lancs.
1887 Sept. 17 E1899 June 10	FIDDIAN, W.	Engineer to Stourbridge and Stour Valley Sewerage Boards. Old Bank Offices, Stourbridge.
P1899 Jan. 21	FIDLER, A., M. Inst. C.E. ..	Borough Engineer, Northampton.
G1891 June 25 T1906 Sept. 22	*FINCH, A. R., A. M. Inst. C.E.	Borough Surveyor, Kensington.
G1898 June 30 T1904 Jan. 23	*FINCH, E. E., A. M. Inst. C.E.	Public Health Department, Engineer's Office, Guildhall, E.C

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Date of Election and Transfer.		
1913 July 16	FINCH, W.	County Surveyor, Cumberland. Carlisle.
1904 Nov. 18	FINDLAY, J. R.	Burgh Surveyor, Leith.
1894 Jan. 13	FINDLAY, R., A.M. Inst. C.E.	Surveyor, Eltham Green, S.E.
G1892 May 28 T1897 Jan. 16 R1903 July 25	*FITTON, G.	8 John Dalton Street, Manchester.
1918 Mar. 15	FITZGERALD, M. E. W. ..	Surveyor to the Rural District Council, Warmley, nr. Bristol.
1903 May 16	FITZMAURICE, Sir M., C.M.G., M. Inst. C.E.	9 Victoria Street, S.W.
1912 Dec. 7	FLEMING, J. J.	Borough Surveyor, Waterford, Ireland.
1913 Jan. 4	FLETCHER, W. T.	County Surveyor, Dorset. Dorchester.
1906 Sept. 22	FORBES, A.	County Road Surveyor, Fife C.C. Queen Anne Street, Dunfermline.
G1895 July 27 T1899 Jan. 21	*FORBES, A. H.	Borough Surveyor, Saffron Walden.
A 1904 Aug. 27 TAM 1911 July 29 T 1912 June 1	FORBES, W.	First Engineering Assistant to Burgh Engineer, Edinburgh.
G1903 Feb. 21 TA1908 Sept. 5 TAM1911 July 29 T1912 Feb. 10	*FOSTER, J. W.	Chief Assistant to City Engineer, Bradford.
G1903 June 6 TAM1908 Sept. 5 T1911 July 29	*FOSTER, W. A., A.M.Inst.C.E.	Richmond Chambers, Blackburn.
G1909 July 17 TAM1911 July 29 T1912 Apr. 27	*FOTHERGILL, J. R.	Borough Engineer's Office, Bexhill-on-Sea.
G1901 June 8 TA1901 Oct. 19 T1907 Sept. 7	*FOWLDS, W., A. M. Inst. C.E.	Borough Engineer, Keighley.
1873 May 2	FOWLER, ALFRED M., M. Inst. C.E. (*Past President.*)	Hendersyde, Ascot.
G1896 Jan. 18 TA1904 May 28 T1906 May 26	*FOX, S. F. L., Assoc. M. Inst. C.E.	Main Drainage Works, Cairo, Egypt.
1911 Apr. 29	*FRANK, T., A. M. Inst. C.E...	City Surveyor, Town Hall, Newark-on-Trent.
G1898 June 30 T1902 Nov. 8	*FRASER, R. W.	Surveyor to the Urban District Council, Hoylake, Cheshire.
1912 July 27	FREEMAN, A.	Surveyor to the Urban District Council, Rickmansworth.
P1895 Oct. 19	FROST, H.	Surveyor to the Urban District Council, Gosport and Alverstoke. Gosport.
1887 June 18 R1898 Jan. 15	FRY, W. H., A.M. Inst. C.E.	9 High Street, Gosport.

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Date of Election and Transfer.		
G1901 May 11 TA1902 Jan. 25 TAM1911 July 29 T1912 Feb. 10	*GAIR, J.	Assistant Borough Surveyor, Town Hall, Marylebone.
A1903 Mar. 21 PTAM1909 Jan. 23 T1909 Mar. 27	GALBRAITH, A. R., M.Inst. C.E.I.	Director of Public Works, Zanzibar Protectorate, East Africa.
1885 June 6	GAMMAGE, J.	Borough Surveyor, Dudley.
1913 Apr. 19	GANDY, W. W.	Engineer and Surveyor to the Urban District Council, Eastleigh and Bishopstoke.
1910 Mar. 12	GARRETT, H. A., A. M. Inst. C.E.	Borough Surveyor, Torquay.
1886 Mar. 13 B1902 Feb. 22	GASKELL, P.	Albert Chambers, Carr Lane, Hull.
1902 Jan. 25 B1909 Apr. 23	GENT, T. W. B.	District Surveyor, Salford Hundred. 24 Clarendon Crescent, Eccles, near Manchester.
1902 Feb. 22	GEORGE-POWELL, J.	County Surveyor, Wiltshire, Trowbridge.
1905 Jan. 28	GETTINGS, C. F.	County Surveyor, Shire Hall, Worcester.
G1903 June 25 T1909 July 17	*GETTINGS, S. S., A.M. Inst. C.E.	Surveyor to the Urban District Council, Tring.
AM1911 Mar. 4 T1911 July 29	GIBBINS, F. R., B.Sc. (Lond.), A. M. Inst. C.E.	Town Hall, Manchester.
1901 Oct. 19	GIBBS, A. G.	Surveyor to the Rural District Council, Midhurst, Sussex.
1900 Mar. 10	GIBSON, S.	Surveyor to the Urban District Council, Biddulph.
1910 Apr. 23	GIBSON, W. L.	County Engineer, Western Division, Perthshire. Dunblane.
1913 Apr. 19	GILL, C. A.	Chief Assistant to City Water and Electrical Engineer, Peterborough.
1913 Apr. 19	GILLARD, C.	Chief Assistant, Borough Surveyor's Office, Torquay.
1899 June 10	GLADWELL, A.	Engineer and Surveyor, Rural District Council, Eton. 160 High Street, Slough, Bucks.
1904 Jan. 23	GLEDHILL, G.	Surveyor to the Urban District Council, Balby with Hexthorpe.
1893 May 13	*GLOYNE, R.M., M. Inst. C.E.	District Engineer, L.C.C., Spring Gardens, S.W.
G1898 Jan. 15 A1903 Jan. 17 AM1907 Nov. 2 T1910 Jan. 22	*GODFREY, C. H., A.M. Inst. C.E.	Engineer and Surveyor, Municipal Council. Shanghai (*via* Siberia).
1895 Jan. 19	GOLDER, T. C.	Borough Surveyor, Deal.
AM1912 Jan. 13 T1912 July 11	GOLDSMITH, H. E.	Engineering Assistant, P.W.D., Hong Kong.
1911 Mar. 4	*GOODE, W. J.	Engineer and Surveyor to the Urban District Council, Buckfastleigh.
AM1907 Sept. 7 T1911 July 29	GOODWIN, J. D.	Borough Engineer, Ashfield, N.S.W.
1911 Jan. 21	*GOODWIN, W. J., A.M. Inst. C.E.	City Engineer, Salisbury.

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Date of Election and Transfer.		
1886 June 12	GOODYEAR, H., Assoc. M.Inst. C.E.	Borough Surveyor, Colchester.
A1907 Apr. 27 TAM1908 Feb. 29 T1911 July 29	*GOOSEMAN, A. T.	Borough Engineer, Wigan.
1897 June 19	GORDON, F.	Surveyor to the Rural District Council, Halifax. Clifton, Brighouse.
G1894 Jan. 13 TA1902 July 10 TAM1911 July 29 T1912 Feb. 10	*GORDON, J., A.M.Inst.C.E.	Assistant Burgh Surveyor, Aberdeen.
AM1908 June 25 T1911 July 29	GORDON, T. W.	Assistant City Engineer, Nottingham.
1912 July 11	GORMAN, J.	State Engineer to Govt. of Kedah, Malay States.
1913 Sept. 6	GORNALL, W...	Chief Assistant Engineer to the Rural District Council, Hendon. Gt. Stanmore.
1899 June 10	GOUDIE, A. H.	Burgh Engineer, Stirling.
1911 July 5	GRANT, A. L...	Surveyor, Rural District Council. 15 High Street, High Wycombe.
G1897 June 19 T1901 Dec. 7	*GRANT, F. T...	Borough Surveyor, Gravesend.
1905 Sept. 23	GRAY, C. C.	Surveyor to the Urban District Council, Scunthorpe, Lincs.
G1887 Feb. 5 PT1898 Apr. 22	*GREATOREX, A. D., M. Inst. C.E. (*Past President. Member of Council.*)	Borough Surveyor, West Bromwich.
1899 June 10	GREEN, G., M. Inst. C.E. ..	Borough Engineer, Wolverhampton.
1901 Feb. 16	GREEN, J. S.	Borough Engineer, Haslingden.
1897 Mar. 13	GREEN, W.	Surveyor to the Urban District Council, Castleford.
1912 Dec. 7	GREENHILL, F. M.	Deputy City Engineer and Surveyor, Cardiff.
A1901 Dec. 7 T1903 Dec. 12	GREENSHIELDS, N., Assoc. M. Inst. C.E.	Borough Engineer, Bedford.
1890 May 3 R1898 Apr. 23	GREENWELL, A., Assoc. M. Inst. C.E.	30 Furnival Street, Holborn, E.C.
G1893 Jan. 14 TA1901 Oct. 19 TAM1908 Sept. 5 T1911 July 29	*GREENWOOD, J. P., A.M.Inst. C.E.	Deputy Borough Surveyor, Burnley.
1898 Mar. 19	GREGORY, T.	Surveyor to the Urban District Council, Newburn-on-Tyne.
1913 Jan. 4	GREGORY, W...	District Surveyor, Herts County Council. Royston, Herts.
1892 Jan. 16	GREGSON, G.	Surveyor to the Rural District Council, Durham.
1886 Oct. 16	GREGSON, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Padiham, near Burnley.
1913 Mar. 15	GREIG, F. W...	Chief Assistant, County Surveyor's Office, Maidstone, Kent.
1882 Sept. 30	GRIEVES, R.	Surveyor to the Urban District Council, Blyth, Northumberland.

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Date of Election and Transfer.		
1897 June 19	GRIEVES, W. H.	Surveyor to the Urban District Council, Sutton, Surrey.
1904 Oct. 29	*GRIFFITHS, H. Ll.	Borough Surveyor, Brecon.
1908 June 25	GRIMWOOD, G. F.	Borough Engineer, Monmouth.
AM1911 Mar. 4 T1911 July 29	GROVE, F.	Assistant County Surveyor, Surrey. County Hall, Kingston.
1912 Sept. 9	GROVES, E. D.	Surveyor and Waterworks Engineer, Urban District Council, St. Austell.
1898 Dec. 17	GUILBERT, T. J.	States Surveyor, Guernsey.
1909 Mar. 27	GULLAN, H. F., M. Inst. C.E.	Superintendent of Works, City Hall, Belfast.
1912 July 11	GURNEY, B. G.	Surveyor to the Urban District Council, Ledbury, Hereford.
1913 Apr. 19	GURNEY, M. G.	Surveyor to the Urban District Council, Linslade.
G1905 June 22 T1911 July 5	*HADFIELD, J. R.	Town Surveyor, Urban District Council, Uttoxeter.
A1902 Mar. 22 TAM1907 Dec. 14 T1909 Sept. 4	HADFIELD, W. J.	Surveyor of Highways, Town Hall, Sheffield.
1897 June 19	HAGUE, S.	Borough Surveyor, Dukinfield.
G1897 June 19 TA1901 Oct. 19 TAM1908 June 25 T1911 July 29	*HAIGH, W. H., A.M.Inst.C.E.	City Engineer's Office, City Hall, Cardiff.
1906 June 28	*HAILSTONE, T. H.	Surveyor to the Urban District Council, Birstall, near Leeds.
1896 Apr. 25	HAINSWORTH, M.	Surveyor to the Urban District Council, Teddington.
1902 Sept. 6	HALE, A., M. Inst. C.E.I. ..	Municipal Engineer, Howrah, Bengal.
G1899 Dec. 16 T1901 Oct. 19	*HALL, C...	Surveyor to the Urban District Council, Droylsden, near Manchester.
1902 Nov. 8	HALL, E.	Borough Surveyor, Carnarvon.
1912 July 11	*HALL, H. L.	Deputy Engineer, Borough Engineer's Office, Batley.
1884 Apr. 19 R1903 Mar. 21	HALL, J., M. Inst. C.E.	28 Esplanade Road, Bombay. *Hon. Sec.*, Indian District.
1900 June 16	HALLAM, R.	Surveyor to the Rural District Council, Eton.
1901 May 11	HALLER, J. C.	Surveyor to the Urban District Council, Carlton, near Nottingham.
1905 June 22	*HALSTEAD, B.	Surveyor to the Urban District Council, Brierfield, Lancs.
G1909 June 5 T1910 Sept. 17	*HAMBY, C. L.	Borough Surveyor, Beccles.
1887 Mar. 12	HAMBY, G. H., A.M.Inst.C.E.	Borough Engineer, Lowestoft.

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Date of Election and Transfer.		
1913 Apr. 19	Hamer, H.	Deputy Borough Engineer, Accrington.
1904 Mar. 26	Hammond, H.	County Engineer, Hobson C.C. Council Chambers, Dargaville, Auckland, N.Z.
1897 Feb. 13	Hamp, H. J., Assoc. M. Inst. C.E.	Borough Surveyor, Swindon.
1913 Apr. 19	Hannigan, J. J.	County Surveyor, Monaghan.
1896 Jan. 18	Hara, R.	32 Nichomi, Ichigatachima, Tokio, Japan.
1899 June 29	*Hargreaves, J. E.	Surveyor to the Urban District Council, Farnborough, Hants.
G1901 June 27 TAM1909 Dec. 11 T1911 July 29	*Harlow, W. W. R., A.M.Inst. C.E.	Deputy City Engineer, Carlisle.
1899 May 6	Harman, E. A., M. Inst. C.E.	Corporation Gas Engineer, Huddersfield.
1897 Mar. 13	Harpur, A. O.	Surveyor to the Urban District Council, Caerphilly.
1905 Jan. 28	Harpur, J. L.	Town Surveyor, Brierley Hill.
A1907 Mar. 2 TAM1907 Dec. 14 T1911 Apr. 29	Harpur, S. J.	Engineer and Surveyor to the Urban District Council, Maesteg.
1894 Mar. 3	HARPUR, W., M. Inst. C.E. (*Past President. Member of Council.*)	City Engineer, Cardiff. *Chairman*, South Wales District.
1910 Dec. 10	Harpur, W. L.	County Roads Surveyor, Breconshire County Council.
1896 Jan. 18	Harris, F.	Surveyor to the Rural District Council, Tonbridge. Bidborough, Tunbridge Wells.
1911 Oct. 21	Harris, F. J.	Surveyor to the Rural District Council, Holsworthy. Uplands Terrace, Holsworthy, North Devon.
1911 Dec. 2	Harris, J. P.	County Hall, Spring Gardens.
AM1908 Dec. 5 T1911 July 29	Harris, J. W.	Surveyor to the Rural District Council, Wantage.
G1901 June 8 T1907 Jan. 19	Harris, K. J. S.	Borough Surveyor, Weymouth.
1901 May 11	Harrison, A., M.Inst.C.E. ..	Borough Engineer, Southwark. Town Hall, Walworth Road, S.E.
1906 Apr. 28	*Harrison, E. Y., Assoc. M. Inst. C.E.	Surveyor and Water Engineer to the Urban District Council, Wellingborough.
1899 June 29	Harrison, G. F. P.	Surveyor to the Rural District Council, East Stow. Stowmarket, Suffolk.
1913 Feb. 8	Harrison, H. L.	District Surveyor, West District, Bedfordshire C.C. 1 Russell Avenue, Bedford.
G1900 Mar. 19 T1905 Mar. 3	*Harrison, J. W.	Surveyor to the Rural District Council, Uxbridge.
G1903 June 25 T1908 Oct. 24	*Harrison, P. T., A.M. Inst. C.E.	Borough Surveyor, Chelmsford.

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Date of Election and Transfer.		
AM1910 Mar. 12 T1911 July 29	HARRISON, P. W.	Godahena Kepitgalla Katugastola, Ceylon.
G1907 Nov. 2 TAM1910 June 16 T1911 July 29	*HARRISON, W. A.	Chief Assistant, Council Offices, Long Eaton, Derbyshire.
1912 Mar. 2	HARROP, T.	Surveyor to the Urban District Council, Bispham with Norbreck. 23 Warbreck Drive, Blackpool.
1913 Sept. 6	HART, A. V.	County Road Surveyor, Dumfries.
1905 Sept. 23	HART, G. A.	Sewerage Engineer, Municipal Buildings, Leeds.
1909 June 5	*HARTFREE, G. B.	Surveyor to the Urban District Council, Alton.
1896 Oct. 24	HARTLEY, T. H.	Borough Surveyor, Colne.
1912 July 27	HARVEY, F. C.	Assistant Surveyor to the Urban District Council, Gosport and Alverstoke.
1911 Oct. 21	HARVEY, H. S.	Borough Surveyor, Evesham.
1913 Apr. 19	*HARVEY, P. E.	Assistant Borough Surveyor, Worthing.
1893 Oct. 21	HARVEY, T. F., M. Inst. C.E.	Waterworks Engineer, Merthyr Tydvil Corporation.
1913 June 21	HATTERSLEY, J. E.	Surveyor to the Urban District Council, Saxmundham, Suffolk.
1907 Apr. 27	HAWKE, W. C., A.M. Inst. C.E.	Borough Surveyor, Dover.
1906 Dec. 15	HAWKINS, J. F.	County Surveyor, Roads and Bridges, Berkshire. Reading.
1892 Apr. 23	HAWLEY, G. W.	Highway Surveyor, Rural D.C., Basford. Burton Buildings, Parliament St., Nottingham.
1913 Feb. 8	HAYLOR, B.	Deputy Engineer, Urban Dis- Council, Willesden. Public Offices, Dyne Road, Kilburn.
1902 July 10	HAYNES, H. T., Assoc. M.Inst. C.E.	Town Hall, Fremantle, West Australia.
G1897 June 19 T1898 Jan. 15	*HAYWARD, T. W. A., M.Inst. C.E. (*Vice-President.*)	Borough Surveyor, Town Hall, Battersea.
G1899 Jan. 12 T1903 June 25	*HAYWOOD, S. S.	Borough Engineer, Brighouse.
1907 Mar. 2	HEAP, J. A.	Borough Surveyor, Todmorden.
1899 June 10	HEATH, J.	Surveyor to the Urban District Council, Urmston.
G1903 Jan. 17 A1905 Apr. 29 TAM1910 Mar. 12 T1911 July 29 R1912 Jan. 13	*HEATH, J. R...	Deputy Borough Surveyor, Stoke-on-Trent.
1912 June 1	HEATHER, F.	Surveyor to the R.D.C., South Stoneham, Hants.
1909 Dec. 11	HECKFORD, H., M. Inst. C.E.	Borough Surveyor, Poplar, E.
G1908 Feb. 29 T1910 Dec. 10	*HEDGES, H. N.	Surveyor, Rural District Council, Berkhampstead. 55 Western Road, Tring.

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Date of Election and Transfer.		
G1893 Jan. 14 T1910 Mar. 12	*HELLAWELL, O.	District Surveyor, Withington, Manchester.
1911 Oct. 21	HENDERSON, A. F.	Municipal Engineer, Chittagong, Eastern Bengal.
1890 Feb. 1 R1908 Jan. 18	HENDERSON, A. J., Assoc. M. Inst. C.E.	c/o Post Office Box 117, North Vancouver, British Columbia.
1897 Feb. 13	HENRY, T.	Surveyor to the Rural District Council, East Retford. Moorgate Park, Retford, Notts.
1903 Dec. 12	HENSHAW, R. S.	Surveyor to the Urban District Council, Portland.
1892 June 11	HERON, J., B.E., B.A., M.Inst. C.E.	County Surveyor, Co. Down. Courthouse, Downpatrick, Ireland.
1902 May 10	HESLOP, R.	Surveyor to the Urban District Council, Tanfield, co. Durham
G1905 Dec. 9 TA1906 Dec. 15 T1909 Jan. 23	*HEWITT, F.	Surveyor to the Rural District Council, Kiveton Park, near Sheffield.
1913 July 16	HIBBERD, W. L.	Highway Surveyor to the Rural District Council. Havant. Purbeck House, West Street, Havant.
AM1908 July 18 T1911 July 29	HICKS, W. R., A. M. Inst. C.E.	Deputy Borough Engineer, Ealing, W.
1894 July 7	HIGGENS, T. W. E., Assoc. M. Inst. C.E.	Borough Surveyor, Town Hall, Chelsea, S.W.
1898 May 21	HIGGINS, J.	Chief Engineer, Grey Co., New Zealand.
1913 Jan. 4	HILL, F...	Deputy Borough Surveyor, Lancaster.
G1903 Oct. 17 T1906 Nov. 8	*HILL, H. F.	Surveyor to the Urban District Council, Ware.
AM1909 Dec. 11 T1911 July 29	HILL-WILLIS, S. A.	Surveyor to the Urban District Council, Tilbury.
G1900 Mar. 10 TA1902 May 10 TAM1911 July 29 T1912 Feb. 10	*HINCHLIFF, E. R., A.M.Inst. C.E.	Deputy Surveyor, Council Offices, Barry.
1913 Jan. 4	HINDHAUGH, R. W.	Surveyor to the Urban District Council, Ham, Surrey.
AM1910 Mar. 12 T1911 July 29	*HINDLE, L. M.	Assistant Surveyor, Urban District Council, Chadderton.
1902 July 10	*HINES, C. E.	Surveyor to the Urban District Council. Windermere.
A1905 Jan. 28 T1908 Dec. 5	HIPWOOD, J. W., A.M.Inst. C.E.	Borough Engineer, Morecambe.
1898 Sept. 3	HIRST, R. P., A.M. Inst. C.E.	77 Scarisbrick New Road, Southport.
1909 Dec. 11	*HODGSON, C. F.	Surveyor to the Urban District Council, Otley, Yorks.
1895 June 27	HODGSON, W...	Surveyor to the Urban District Council, Keswick.
1896 Apr. 25 R1901 May 11	*HOGBIN, L. W.	"Rowena," Preston Road, Leytonstone, N.E.

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Date of Election and Transfer.		
S1911 Oct. 21 T1912 Dec. 7	*HOLDEN, F. H.	Engineering Assistant, Borough Engineer's Office, Accrington.
1913 Apr. 19	HOLLOWAY, E.	Surveyor to the Rural District Council, Evesham and Pebworth, Worcestershire.
G1900 Aug. 25 TA1902 Mar. 22 TAM1911 July 29 T1912 Feb. 10	*HOLLOWAY, W. C...	Engineer and Surveyor, Urban District Council, Waltham Cross.
P1904 Aug. 16	HOLMES, F. G.	Burgh Surveyor, Govan. *Chairman*, Scottish District.
1892 Mar. 11	HOLMES, G. W., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Walthamstow, N.E.
1912 July 11	HOLMES, H.	Borough Surveyor, Ossett.
G1907 Dec. 14 TAM1909 Apr. 24 T1911 July 29	*HOLT, P., Assoc. M. Inst. C.E.	Assistant Borough Surveyor, Rawtenstall.
G1903 Dec. 12 T1904 Oct. 29	*HOLT, R. B.	Permanent Way Engineer, Sovereign St. Depôt, Leeds.
1901 Dec. 7	*HOLT, W., Assoc.M.Inst.C.E.	Surveyor to the Urban District Council, Sale, Cheshire.
AM1910 Mar. 12 T1911 July 29	HONEY, R. L...	Deputy Borough Engineer, Chatham.
1884 Oct. 9	HOOLEY, E. P., M. Inst. C.E. (*Past-President. Member of Council.*)	County Surveyor, Nottingham. *District Representative*, East Midland District.
1912 Dec. 7	HOPE, P. M..	Engineer and Surveyor, Rural District Council, West Ward, Westmorland. Old Bank, Appleby.
1898 Jan. 15	HOPKINSON, F.	Surveyor to the Rural District Council, Blyth and Cuckney. 66 Bridge Street, Worksop.
1891 Dec. 12	HORAN, J., M.E., M.Inst.C.E.	County Surveyor, 82 George Street, Limerick, Ireland.
A1902 Feb. 22 T1906 Nov. 3	HORTON, J. W., Assoc.M.Inst. C.E.	County Surveyor, Derbyshire.
1911 Oct. 21	HOSKEN, A.	Borough Engineer, Smethwick.
AM1911 Mar. 4 T1911 July 29	*HOSKEN, W.	District Surveyor, West Sussex County Council. County Surveyor's Office, North Street, Horsham.
1913 June 21	HOSKING, H. A.	Surveyor to the Rural District Council, St. Germans. "Landrake," St. Germans, Cornwall.
1894 Mar. 3	HOWARD, H.	Surveyor to the Urban District Council, Littlehampton.
1880 May 27	HOWCROFT, J...	Surveyor to the Urban District Council, Redcar, Yorkshire.
G1903 Jan. 17 T1909 Feb. 27	*HOWELLS, D. P., A.M.Inst. C.E.	Town Engineer, Benoni, Transvaal.
1896 Feb. 22	HOWSE, W. T.	Surveyor to the Urban District Council, Bexley.
1897 June 17	HUGHES, H. T.	Highway Surveyor, Hayfield Road, Chapel-en-le-Frith.

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Date of Election and Transfer.		
1913 Feb. 8	HUMPHREYS, G. W.	Chief Engineer, London County Council, Spring Gardens, S.W.
1899 June 1 / B1912 Jan. 13	HUMPHRIES, H. H.	Holydene, Erdington, Birmingham.
1911 Mar. 4	HUNT, A. A.	County Surveyor, West Suffolk. · Bury St. Edmunds.
1897 July 8	HUNTER, T.	Borough Engineer and Surveyor, Leigh.
G1891 Aug. 1 / T1896 Apr. 25	*HURD, H.	Surveyor, Urban District Council, Broadstairs.
1913 Sept. 6	HURST, J. S.	Borough Surveyor, Southwold.
1912 Dec. 7	HUTCHINSON, J. A.	Water Engineer, Urban District Council, Paignton.
G1901 Aug. 24 / T1901 Dec. 7	*HUTTON, F.	Surveyor to the Urban District Council, Ashton-on-Mersey.
A1902 Feb. 22 / TP1903 Mar. 21	HUTTON, S.	Surveyor to the Urban District Council, Exmouth.
1898 May 21 / B1906 Mar. 3	INGAMELLS, E. W...	Surveyor, Pokesdown.
G1895 Apr. 20 / T1896 Oct. 24	*INGHAM, W., M. Inst. C.E. ..	Chief Engineer, Rand Water Board, Johannesburg, Transvaal.
1912 Mar. 2	INGLIS, H.	Burgh Engineer, Airdrie.
1899 Feb. 25	INGRAM, S.	
1888 Nov. 17	IRVING, W. E.	"Rochdale," Murarrie, Brisbane, Australia.
1912 July 27	IVES, L.	Deputy City Surveyor, Wakefield.
1904 May 28	IVESON, J. A...	Surveyor to the Rural District Council, 2 Nares Street, Scarborough.
1900 July 19	JACK, G. H.	County Surveyor, Herefordshire. Hereford.
1913 Apr. 19	JACKSON, A. E.	Borough Engineer and Surveyor, Southport.
1893 Oct. 21 / B1909 Mar. 27	JAFFREY, W.	Bridge Chambers, Matlock.
1896 Oct. 24	JAMES, A. C., A.M. Inst. C.E.	Surveyor to the Urban District Council, Grays Thurrock. Grays.
1908 Dec. 12	JAMES, C. C., M.Inst.C.E. ..	The Ministry, P.W.D., Cairo. 28 Victoria Street, S.W.
G1887 Oct. 22 / T1890 Mar. 29	*JAMESON, M. W., A. M.Inst. C.E.	Borough Engineer, Stepney. Gt. Alie St., Whitechapel, E.
1897 Feb. 13	JARVIS, R. W.	Surveyor to the Rural District Council, Tenbury.
1885 Apr. 18	JEEVES, E.	Surveyor to the Urban District Council, Melton Mowbray.
G1898 Jan. 15 / T1903 Oct. 17	*JEFFES, R. H., A. M. Inst. C.E.	Surveyor to the Urban District Council, Malden.
G1896 Jan. 18 / T1896 Oct. 24	*JENKIN, C. J., M. Inst.C.E. ..	Surveyor to the Urban District Council, Finchley, N.

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Date of Election and Transfer.		
1899 June 10	JENKINS, D. M., A.M.Inst.C.E.	Borough Surveyor, Neath.
G1897 July 21 TA1902 Nov. 8 TAM1911 July 29 T1912 Feb. 10	*JENKINS, R. J.	Chief Assistant, Borough Engineer's Office, Town Hall, Portsmouth.
AM1911 Mar. 4 T1911 July 29	*JENKINS, B. H.	Surveyor to the Urban District Council, Skegness.
G1906 Dec. 15 TAM1911 July 29 T1912 Feb. 10	*JENKINSON, F. C.	Chief Assistant Engineer, Rural District Council, Imperial Buildings, Rotherham.
G1900 June 16 A1901 Oct. 19 AM1907 Nov. 2 T1908 May 23	*JERRAM, G., A.M. Inst. C.E.	Surveyor to the Urban District Council, Merton.
1892 July 21	JEVONS, J. H., A.M. Inst. C.E.	Borough Surveyor, Hertford.
1904 May 28	JOHNSON, J.	Borough Surveyor, Rawtenstall.
1895 June 27	JOHNSTON, J., M. Inst. C.E.	Waterworks Engineer, Brighton.
G1897 June 19 TA1902 Jan. 25 TAM1907 Dec. 14 T1911 July 29	*JOHNSTON, B. W.	Deputy Borough Engineer, Birkenhead.
1883 Aug. 4 R1902 Nov. 8	JONES, V.D., Lt.-Col. A. S., M. Inst. C.E.	Ridge Cottage, Finchampstead, Berks.
1894 July 7	JONES, CHRIS.	Borough Surveyor, Hythe, Kent.
G1907 Sep. 7 T1910 Mar. 12	*JONES, F. E.	Engineer and Surveyor to the Urban District Council, Tyldesley, Lancs.
G1903 May 16 T1904 June 26	*JONES, F. W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Frome, Somerset.
G1901 June 8 TA1904 Mar. 26 TAM1908 Feb. 29 T1911 July 29	*JONES, H. O.	Deputy Borough Engineer and Surveyor, Folkestone.
1874 Jan. 29	JONES I. M., M. Inst. C.E. ..	Consulting Engineer, Chester.
1894 June 21	JONES, J. O.	Surveyor to the Rural District Council, Biggleswade.
1900 Mar. 10	JONES, T. C.	Surveyor to the Urban District Council, Frimley. Camberley, Surrey.
1892 May 28	JONES, W., Assoc.M.Inst.C.E.	Surveyor to the Urban District Council, Colwyn Bay.
AM1911 Apr. 29 T1911 July 29	JONES, W.	Borough Surveyor, Thetford Norfolk.
1908 Sept. 5	JONES, W. H. M.	City Surveyor, Chester.
1897 Feb. 13	JONES, W. J.	Surveyor to the Urban District Council, Rhondda.
1898 Apr. 23	JONES, W. P.	Surveyor to the Urban District Council, Glyncorrwg.
1891 June 25	JUKES, W. H.	Surveyor to the Urban District Council, Tipton.
G1895 Oct. 19 AM1907 Nov. 2 TP1908 June 25	*JULIAN, J., B.E.	Borough Surveyor, Cambridge.

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Date of Election and Transfer.		
1895 July 27 R1899 Dec. 16	KAY, W. R., A.M. Inst. C.E.	Surveyor General of Highways, Athol Street, Douglas, Isle of Man.
1892 Apr. 23	KENNEDY, J. D.	Borough Surveyor, East Retford.
1905 Jan. 28	*KENYON, L.	Surveyor to the Urban District Council, Tottington.
A1902 May 10 TAM1911 July 29 T1912 Mar. 2	KER, A. M., B.Sc. (Vict.), A.M.Inst.C.E.	Borough Engineer, Town Hall, Warrington.
1912 Dec. 7	KERSHAW, J.	Surveyor to the Rural District Council, Aethwy, Anglesey.
1892 July 11	KIDD, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Swadlincote, Burton-on-Trent.
G1896 June 25 A1906 Dec. 15 TAM1910 Mar. 12 T1911 July 29	*KIESER, W. H. G., Assoc. M. Inst. S.E.	District Engineer, City Engineer's Office, Bristol.
1899 Oct. 21	KILLICK, J. S., A.M. Inst. C.E.	The Road Board, Queen Anne's Chambers, Broadway, Westminster, S.W.
1899 June 29	KILLICK, P. G.	Borough Surveyor, Finsbury, E.C.
AM1911 Sept. 23 T1912 Feb. 10	KILMISTER, C. H.	Office of the Works Engineer, Colombo Municipality, Ceylon.
AM1908 Apr. 25 T1911 July 29	*KING, G. R.	Deputy Surveyor, Urban District Council, Twickenham.
G1906 May 26 TA1909 Mar. 27 TAM1911 July 29 T1912 Feb. 10	*KING, J. STUART, A.M.Inst. C.E.	City Engineer's Office, Council House, Birmingham.
1902 May 10 R1903 July 25	KINNISON, A. M.	Abbey Cottage, Leek, Staffs.
1909 Mar. 27	KIRBY, F. O., M.Sc.	Borough Surveyor, Doncaster.
1888 Sept. 15	KIRK, T., Assoc. M. Inst. C.E.	City Engineer, Brisbane.
1913 Apr. 19	KIRKLAND, W.	County Road Surveyor, Co. Caithness.
1907 May 25	KIRKPATRICK, C. R. S., M.Inst. C.E.	Chief Assistant Engineer to Port of London Authority, 109 Leadenhall Street, E.C.
1895 Oct. 19	KNAPP, R. W.	Borough Surveyor, Andover.
1903 June 25	*KNEWSTUBB, J. J.	Surveyor to the Urban District Council, Penrith.
G1903 June 25 TA1909 Feb. 27 TAM1911 July 29 T1913 May 24	*KNIGHT, R. B.	City Engineer, Fort William, Ontario, Canada.
1907 Sept. 7	KUSAKABE, B.	Chief Engineer to Municipality, Tokio, Japan.
1884 Oct. 9	LACEY, F. W., M.Inst.C.E. ..	Borough Engineer, Bournemouth.
G1893 Jan. 14 T1895 Mar. 16	*LACEY, G. W.	Borough Surveyor, Oswestry.
1909 July 17	LADELL, H. M.	Town and Water Engineer, Wynberg, Cape Colony.
1900 Dec. 15	LAILEY, H. G. N.	Surveyor to the Urban District Council, Trowbridge.

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Date of Election and Transfer.		
1900 July 19	LAITHWAITE, V.	Surveyor to the Urban District Council, Turton, 2 Rigby Lane, Bradshaw, near Bolton.
1913 Feb. 8	LAKE, C. A.	Highway Surveyor, Rural District Council, Thirsk, Yorks.
AM1908 Sept. 5 T1911 July 29	LAKE, T...	Highway and Building Surveyor, Rural District Council, Bourne, Lincs.
G1905 Dec. 9 TAM1911 July 29 T1912 Dec. 7	*LAKE, W. S.	Assistant Director of Public Works, P.W.D., Freetown, Sierra Leone, W. Africa.
1904 Apr. 30	LAMBERT, A. P.	Resident Engineer, Port of London Authority, London Dock Improvement, Pierhead Wapping, E.
A1902 Mar. 29 T1905 Oct. 28	LANCASHIRE, W. T., M.Inst. C.E. (*Member of Council.*)	City Engineer, Leeds.
1904 Oct. 13	LANDALE, G.	Burgh Surveyor, Musselburgh.
1913 Jan. 4	LANDER, A. J.	Engineering Assistant, County Surveyor's Office, Middlesex. 63 Victoria Street, S.W.
AM1907 Sept. 7 T1911 Apr. 29	LANE, W. G.	Borough Surveyor and Water Engineer, Dartmouth.
1909 Sept. 4	*LANGLEY, F.	Surveyor to the Urban District Council, Buxton.
1909 June 5	LAPHAM, A. H.	Surveyor to the Rural District Council, Chippenham.
A1901 Dec. 7 TAM1910 Jan. 22 T1911 July 29	LASHMORE, E. W., Assoc. M. Inst. C.E.	Divisional Engineer, City Engineer's Office, Bristol.
1884 July 10	LAWSON, C. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Southgate. District Offices, Palmer's Green, N.
1910 Dec. 10 R1912 Jan. 13	LAWTON, C. E.	City Engineer's Department, Council House, Birmingham.
1900 Mar. 10	LAWTON, C. H.	Surveyor to the Urban District Council, Warminster. Christchurch Cottage, Warminster, Wilts.
1912 Apr. 27	LAYLAND, R. J. W.	Engineer and Surveyor, Rural District Council, Billericay.
G1899 Oct. 21 T1901 May 11	*LEA, M., A. M. Inst. C.E. ..	Chief Engineer, Karachi Municipality, Municipal Office, Karachi, India.
1904 Aug. 31	LEE, J.	Burgh Surveyor, Paisley.
P1896 Oct. 24	LEEBODY, J. W.	County Surveyor, Co. Tyrone (S.)
G1903 June 25 TA1906 Dec. 15 TAM1908 Dec. 5 T1911 July 29	*LEES, H. B., A.M. Inst. C.E.	P.W.D., Colombo, Ceylon.
G1906 Dec. 15 TAM1911 July 29 T1912 Jan. 13	*LEES, R. B.	Surveyor to the Urban District Council, Bradford-on-Avon.
1898 Mar. 19	LEETE, H. J. G.	County Surveyor, Huntingdon.
1880 Apr. 10	LEETE, W. H., A.M.Inst.C.E.	County Surveyor, Bedford.
1894 May 19	LEIGH, W.	Borough Surveyor, Chorley.

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Date of Election and Transfer.		
1873 Feb. 15	LEMON Sir J., M. Inst.C.E. (*Past President and Hon. Treasurer.*)	Stockwell Lodge, The Avenue Southampton.
1913 Feb. 8	LEVERTON, H.	Surveyor to the Urban District Council, Harpenden.
1913 Apr. 19	LEWIS, E. R.	Surveyor to the Rural District Council, Cranbrook.
A1911 Jan. 21 TAM1911 July 29 T1912 Feb. 10	*LIGHBODY, T. H.	Surveyor to the Rural District Council, 20 Marlowes, Hemel Hempstead.
A1907 Sep. 7 TAM1909 Dec. 11 T1911 July 29	LILLEY, A. S...	Surveyor to the Urban District Council, St. Helen's, Isle of Wight. Somerset Road, High Park, Ryde.
AM1908 Dec. 5 T1911 July 29	LINGWOOD, G. W.	Surveyor to the Urban District Council, Stowmarket.
G1901 May 11 TA1901 Oct. 19 TAM1908 Apr. 25 T1911 July 29	*LISMER, A. B., A.M.Inst.C.E.	Assistant Engineer, Town Hall, Edmonton.
G1896 July 25 T1899 Dec. 16 B1903 Feb. 21	*LIVERSEDGE, J. W.	Surveyor to the Urban District Council, Leigh-on-Sea, Essex.
1891 Mar. 21 B1901 Aug. 24	LIVINGSTONE, G., Assoc. M. Inst. C.E.	75 Alexandra Road, Southport.
G1909 Sept. 4 TAM1911 July 29 T1912 Feb. 10	*LLOYD, B. S.	Queen Street Chambers, Maidenhead.
AM1912 Oct. 26 T1912 Dec. 7	*LLOYD, S. C...	District Surveyor, East Suffolk County Council. 31 Berners Street, Ipswich.
1907 May 25	*LLOYD-DAVIES, D. E., M.Inst. C.E.	Chief Engineer, The Municipality, Alexandria, Egypt.
1873 May 2	LOBLEY, J., M. Inst. C.E. (*Past President.*)	Richmond Terrace, Shelton Stoke-on-Trent.
1896 June 25	LOCKE, W. R.	Borough Surveyor, Town Hall Hemel Hempstead.
1889 Sept. 21	LOMAX, C. J., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Gorton. 37 Cross Street, Manchester.
1904 Mar. 26	LONGDIN, H. W.	Surveyor to the Urban District Council, Penge.
AM1910 July 16 T1911 July 29	LONGDIN, W. G.	Municipal Engineer, Lahore.
1896 Oct. 24	LONGFIELD, R. W. F., M. Inst. C.E.	County Surveyor, Co. Cork (W.), Bandon.
1903 Dec. 12 B1908 Feb. 29	LONGLEY, H. B.	Surrey Estate Offices, High Street, Epsom.
1911 Mar. 4	LOUDEN, J.	Burgh Surveyor, Bo'ness.
1901 May 11	LOVEDAY, W. F.	Borough Surveyor, Stoke Newington, N.
1892 Jan. 16	LOVEGROVE, E. J., M. Inst. C.E.	Borough Engineer, Hornsey, N.
1910 Dec. 10	LOW, W. D.	Master of Works and Burgh Surveyor, Greenock.
1913 Sept. 6	LOWE, W. E.	Engineer and Surveyor to the Urban District Council, Pontypridd.

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Date of Election and Transfer.		
1897 July 8	LUMSDEN, J. L.	Burgh Surveyor, Kirkcaldy.
1896 July 25	LUND, C.	Surveyor to the Urban District Council, Cleckheaton.
1913 Feb. 8	*LYDDON, A. J.	Deputy County Surveyor, Essex. Chelmsford.
G1888 July 12 T1897 Oct. 16	*LYNAM, G. T., M. Inst. C.E.	Borough Surveyor, Burton-on-Trent.
1913 Mar. 15	LYNAM, H. V...	Surveyor to the Urban District Council, Alsager, Cheshire.
1913 Jan. 4	LYONS, J. M. C.	Deputy County Surveyor, Co. Louth. Dundalk.
1912 Apr. 27	MACBEAN, D.	Road Surveyor, 39 Union Street, Inverness.
1905 Mar. 3	MCBETH, M. B.	Surveyor to Mid-Argyll District, Argyllshire County Council, County Buildings, Lochgilphead, Argyllshire.
1883 May 30	MACBRAIR, R. A., M.Inst.C.E.	City Engineer, Lincoln.
1913 Feb. 8	MACARTNEY, W. A.	Burgh Surveyor and Engineer, Johnstone.
1912 Jan. 13	MCCURDIE, W. D. R.	City Engineer, Dunedin, N.Z.
1900 Feb. 10	MCDERMID, C.	Surveyor to the Urban District Council, Eston.
1912 Apr. 27	MCDONNELL, F. H.	Borough Engineer, Lyme Regis.
1913 Sept. 6	MCGREGOR, G. H...	Burgh Surveyor, Lerwick.
1897 Jan. 16	MACKENZIE, D.	District Master of Works, County Buildings, Dunfermline.
G1906 Dec. 15 TA1907 Nov. 2 TAM1911 July 29 T1912 Feb. 10	*MACKENZIE, W. H.	Assistant Borough Engineer, Bournemouth.
A1902 Nov. 8 TAM1911 July 29 T1912 Feb. 10	MCKENZIE, L. S., A.M.Inst. C.E. (*Member of Council.*)	City Engineer and Surveyor, Bristol. *District Representative*, Southern District.
1898 June 30	MCKILLOP, R.	Burgh Surveyor, Perth.
1913 June 21	MCLAREN, T.	Deputy Burgh Surveyor, Perth.
1912 Oct. 26	MCLEAN, W. H.	Engineer-in-Chief, Section of Municipalities and Local Commissions, Ministry of Interior, Cairo, Egypt.
1906 Mar. 3	*MADEN, J.	Trust Engr. to the Calcutta Improvement Trust, 5 Clive Street, Calcutta, India.
1898 Feb. 19	*MADIN, W. B.	Surveyor to the Urban District Council, Rushden.
1886 Dec. 18	MAIR, H., M. Inst. C.E. ..	Borough Engineer, Hammersmith, W.
G1905 May 27 TAM1910 May 24 T1911 July 29	*MAITLAND, W. H...	Council Offices, Hoylake.
1892 July 21	MANNING, G. W.	Surveyor to the Rural District Council, Staines.
A1903 Mar. 21 TAM1911 July 29 T1912 Feb. 10	MANNING, W. R., A.M.Inst. C.E.	Assistant Borough Surveyor, Town Hall, Chelsea.

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Date of Election and Transfer.		
G1904 May 28 TAM1911 July 29 T1912 Feb. 10	*MANSFIELD, F.	Borough Surveyor, Abergavenny
G1898 Jan. 15 T1901 Aug. 24	*MARKS, C. W...	Borough Surveyor, Wokingham.
1888 July 12	MARKS, H. C., M. Inst. C.E.	City Surveyor, Carlisle.
G1906 Apr. 28 TAM1909 Feb. 27 T1911 July 29	*MARSH, F. E...	Assistant Engineer, Water Department, Singapore, S.S.
1913 Mar. 15	MARSH, G. R...	District Main Road Surveyor, Dorset County Council. 96 St. Andrews Road, Bridport.
1897 Mar. 13	MARSHALL, J...	Surveyor to the Malling Rural District Council, East Malling, Kent.
A1903 Jan. 17 T1907 Nov. 2	MARSHALL, L. P., M. Inst. C.E.	Chief Engineer, Rangoon Municipality.
1894 Mar. 3 R1908 May 23	MARTEN, H. J., Assoc. M. Inst. C.E.	18 Madeira Road, Streatham, S.W.
G1894 Jan. 13 T1907 Dec. 14	*MARTIN, E. B., M.Inst.C.E. (*Member of Council.*)	Borough Engineer, Rotherham. *District Representative*, North-Eastern District.
P1899 May 6	MASON, C. G., Assoc. M. Inst. C.E.	Borough Surveyor, Guildford.
1904 Oct. 22	MASSIE, C.	Water Engineer, Falkirk.
1890 Mar. 29	MASSIE, F., M. Inst. C.E. ..	Surveyor to the Rural District Council, Wakefield. *Chairman*, North-Eastern District.
1906 Apr. 28	MATHER, H. T.	Surveyor to the Urban District Council, Surbiton.
1912 Oct. 26	MATHISON, J...	Engineer and Surveyor to the Rural District Council, Langport, Somerset.
1912 July 11	MATTHEW, J. C., A.M. Inst. C.E.	Deputy Surveyor to the Urban District Council, Exmouth, Devon.
G1905 May 27 TAM1909 July 17 T1911 July 29	*MATTHEW, S.	Engineering Assistant to Borough Surveyor, Chelmsford.
1898 Dec. 17	*MATTHEWS, E. R., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Bridlington. *District Representative*, North-Eastern District.
1904 May 28	MAUDSLEY, C. W...	Surveyor to the Rural District Council, Alton, Hants
1881 Dec. 10	MAWBEY, E. G., M. Inst. C.E. (*Past President.*)	Borough Engineer, Leicester. *Chairman*, East Midland District.
AM1911 July 5 T1911 July 29	MAXWELL, D...	Burgh Surveyor, Carnoustie.
1912 Sept. 9	MAXWELL, T. H.	Surveyor to the Fylde Rural District Council, Kirklam, near Blackpool.
G1896 July 25 T1902 Sept. 6	*MAXWELL, W. H., Assoc. M. Inst. C.E.	Borough Surveyor, Tunbridge Wells.
G1898 Dec. 17 T1904 June 26	*MAY, C. G.	Deputy Colonial Engineer and Deputy Surveyor General, Penang, S.S.

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Date of Election and Transfer.		
1894 Oct. 20	MAYBURY, H. P., M.Inst.C.E.	Chief Engineer to the Road Board, Queen Anne's Chambers, Westminster, S.W.
1901 Aug. 24	MAYLAN, S.	Surveyor to the Rural District Council, Basford.
1889 May 18	MAYNE, C., M. Inst. C.E. ..	c/o Messrs. J. Pook, 63 Leadenhall Street, E.C.
1912 June 1	MEAD, J. R.	Borough Engineer, Ipswich.
1883 Feb. 17	MEADE, T. DE COURCY, M.Inst.C.E.(*Past President.*)	City Surveyor, Manchester.
1912 July 27	MEESON, A. J.	Engineer and Surveyor to the Urban District Council, Brentwood, Essex.
A1911 Jan. 21 TAM1911 July 29 T1912 Feb. 10	*MERRETT, W. J.	Assistant County Surveyor, Redruth, Cornwall.
1903 June 25 R1908 Jan. 18	*METCALFE, A. J.	District Main Road Surveyor, Ashbourne.
1913 May 24	MIDGLEY, J. C.	Deputy Town Surveyor, Newcastle-on-Tyne.
AM1909 Sept. 4 T1911 July 29	*MILES, E. J.	Deputy Borough Engineer, West Hartlepool.
1912 July 27	MILLARD, G. A.	Surveyor to the Rural District Council, Axminster.
1912 Dec. 7	MILLER, B. A.	Engineer and Surveyor, Urban District Council, Seaford.
G1900 Apr. 21 TA1901 Dec. 7 TAM1908 Feb. 29 T1911 July 29	*MILLER, G. F.	Chief Assistant, Borough Engineer's Office, Hastings.
1893 June 24	MILLER, H., M. Inst. C.E. ..	County Surveyor, East Suffolk, Ipswich.
1902 July 10	MILLER, H.	Surveyor to the Urban District Council, Heysham.
G1906 May 26 TA1908 June 25 T1910 Oct. 29	*MILNER, J. D., A.M.Inst.C.E.	District Engineer, P.W.D., British Uganda.
1897 Jan. 16	*MILNES, G. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stroud.
G1905 May 27 TAM1908 Dec. 5 T1911 July 29	*MINORS, E., B.Sc. Eng. (Lond.), A.M.Inst.C.E.	Chief Assistant to Borough Surveyor, Darlington.
1912 Sept. 9	MITCHELL, G. C.	Assistant Borough Engineer Stockton-on-Tees.
1874 May 23 R1910 Mar. 12	MITCHELL, J.	49 Richmond Road, Birkdale.
1912 Apr. 27	MOIR, R.	County Road Surveyor, Mid-Lothian County Council, County Buildings, Edinburgh.
1896 Oct. 24	MONCUR, J., A.M. Inst. C.E.	County Highway Surveyor, County Buildings, Stafford.
1913 Apr. 19	MONTGOMERY, J. H.	Deputy Engineer and Surveyor, Urban District Council, Llanelly.
1912 Mar. 2	MOON, R. C.	Chief Engineering Assistant, Council Offices, Nuneaton.

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Date of Election and Transfer.		
1898 Apr. 23	MORGAN, E. F.	Borough Road Surveyor, Croydon.
1907 May 25	MORGAN, E. L., A.M.Inst.C.E.	Borough Engineer, Bolton.
1895 July 27	MORGAN, G. S.	Surveyor to the Rural District Council, Llantrissant, Glamorgan.
1892 July 11	MORGAN, J.	Surveyor to the Rural District Council, Pontardawe. Swansea.
1901 June 8	MORGAN, R. P.	Surveyor to the Urban District Council, Towyn.
1910 May 24	MORGAN, S. H., A.M.Inst.C.E.	Surveyor to the Urban District Council, Prestwich.
1874 May 1	MORGAN, W. B., Assoc. M. Inst. C.E.	Surveyor, Weymouth.
1905 Oct. 28	MORLEY, E.	Surveyor to the Urban District Council, Walthamstow.
1913 July 16	MORRIS, C. S.	County Surveyor, Northampton.
1913 Apr. 19	MORT, D.	Surveyor to the Urban District Council, Lymm, Cheshire.
G1899 June 10 TAM1911 July 29 T1912 Apr. 27	*MOSS, P. A.	Engineering Assistant, Town Hall, Upper Street, Islington.
1893 Jan. 14 B1899 May 6	MOSS-FLOWER, T. J., A. M. Inst. C.E.	28 Victoria Street, Westminster, S.W., and Carlton Chambers, Baldwin Street, Bristol.
1903 Feb. 21	MOULDING, T., M. Inst. C.E. (*Member of Council.*)	City Surveyor, Exeter. *District Representative*, South-Western District.
1885 Feb. 7 B1905 Jan. 28	MOUNTAIN, A. H., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council. Barton-on-Irwell. The Thorns, Croft's Bank Road, Urmston, near Manchester.
1913 Jan. 4	MURRAY, G. L.	Surveyor to the Urban District Council, Hexham, Northumberland.
1904 Aug. 6	MURRAY, J.	County Surveyor, Renfrewshire. Paisley.
1904 Aug. 17	MURRAY, J.	Burgh Surveyor, Port Glasgow.
G1902 July 10 A1907 Jan. 19 TAM1910 Mar. 12 T1911 July 29	*NATHANIELSZ, A. H., A.M. Inst. C.E.	District Engineer, P.W.D., Anuradapura, Ceylon.
G1901 Aug. 24 TA1902 Nov. 8 TAM1911 July 29 T1912 Feb. 10	*NEAVE, J.	Chief Assistant, Engineer's Department, Town Hall, Walthamstow.
G1904 Dec. 3 TAM1910 Apr. 23 T1911 July 29	*NEEDHAM, J. E.	Engineering Assistant, P.W.D. Shanghai.
1905 Oct. 28	NELSON, G., A.M. Inst. C.E.	Surveyor to the Urban District Council, Gosforth.
1913 Jan. 4	NEWEY, A. E.	Surveyor to the Rural District Council, Foleshill, nr. Coventry.

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Date of Election and Transfer.		
1897 July 8	NEWMAN, J. S.	Borough Surveyor, Poole.
G1906 Jan. 20 A1907 Nov. 2 TAM1910 Mar. 12 T1911 July 29	*NEWMAN, W. W., A.M.Inst. C.E.	Deputy Surveyor to the Urban District Council, Watford, Herts.
1913 Jan. 4	NEWPORT, B. O. N.	Surveyor to the Urban District Council, Kingsbury.
1897 Feb. 13 R1903 Jan. 17	NEWTON, O. E., M.Inst.C.E.	19 Cooper Street, Manchester.
G1895 Jan. 19 TA1901 Oct. 19 T1902 Mar. 22	*NEWTON, E. B. B., M.Inst. C.E.	Borough Surveyor, Paddington, W.
1888 May 12	NEWTON, W. J., A.M.Inst.C.E.	Borough Surveyor, Accrington.
G1892 Sept. 24 T1899 Feb. 25	*NICHOLS, A. E., M.Inst.C.E.	Borough Engineer, Folkestone.
1913 Apr. 19	NICOL, W.	Burgh Surveyor, Callander.
1904 Aug. 5	NISBET, T., Assoc. M.Inst.C.E.	Master of Works, City Chambers, Glasgow.
1913 Mar. 15	NOONAN, J. J...	County Surveyor, North Riding, Co. Mayo. Ballina.
1887 July 14 R1899 Feb. 25	NORRINGTON, J. P.	78 Leander Road, Brixton Hill, S.W.
G1897 Mar. 13 T1898 Sept. 3	*NORRIS, J. H.	Borough Surveyor, Godalming.
1913 July 16	NORTH, W.	Surveyor to the Rural District Council, Honiton. Bowhay House, Alfington, Ottery St. Mary, Devon.
1900 Dec. 15 R1910 Oct. 29	NUTTALL, H., Assoc. M. Inst. C.E.	"The Laurels," Fulwood, Preston.
1913 Mar. 15	NUTTALL, J.	Highway Surveyor, Rural District Council, Hunslet. Highfield Terrace, Woodlesford, nr. Leeds.
1912 July 11	NUTTALL, J. B.	Borough Surveyor, Heywood.
1899 Feb. 25 R1908 Feb. 29	NUTTALL, W.	2 Belgrave Place, Birkdale, Southport.
G1898 June 30 T1899 Oct. 21	*OAKDEN, R., A.M. Inst. C.E...	Surveyor to the Rural District Council, Newark.
A1902 Jan. 25 T1906 Nov. 3	OAKES, H. H...	Town Surveyor, Ventnor, I. of W.
1912 Dec. 7	OBORN, A. J.	Engineer and Surveyor, Urban District Council, Porthcawl, Glam.
1901 Aug. 24	O'HARA, H.	Surveyor to the Urban District Council, Ballymena, Ireland.
1913 Jan. 4	OWEN, W.	Surveyor to Urban District Council, Menai Bridge.
G1901 Aug. 24 TAM1911 July 29 T1912 Feb. 10	*OXBERRY, F. W.	Borough Engineer, Kendal.

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Date of Election and Transfer.		
1907 Mar. 2	PALK, D. S.	Provincial Engineer, P. W. D., Gold Coast, South Africa.
1896 Apr. 25	PALMER, F. W. J.	Surveyor to the Urban District Council, Herne Bay.
1912 Oct. 26	PALMER, G.	Assistant County Surveyor to the Cornwall County Council, Redruth.
P1900 Mar. 10	PALMER, P. H., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Hastings. *District Representative*, South-Eastern District.
1912 July 11	*PALMER, S.	Borough Surveyor and Water Engineer, St. Ives.
G1901 Feb. 6 TAM1911 July 29 T1912 Feb. 10	*PALMER, W. L. F., Assoc.M. Inst.C.E.	District Engineer, City Engineer's Office, Bristol.
1905 Jan. 28	PANSING, J., A.M. Inst. C.E.I.	Town Surveyor, Wicklow.
1894 Apr. 6	PARDOE, J. C., Assoc. M. Inst. C.E	Surveyor to the Urban District Council, Barry, near Cardiff.
1913 May 24	PARK, E.	Engineer and Surveyor to the Rural District Council, Sedbergh, Yorks.
1913 July 16	PARKER, A. L.	Engineer and Surveyor to the Urban District Council, Oakham.
1876 May 1	PARKER, J., Assoc. M. Inst. C.E.	City Surveyor, Hereford.
1896 Nov. 28 R1903 Feb. 21	PARKER, J. E., A.M.Inst.C.E.	P.O. Chambers, St. Nicholas Square, Newcastle-on-Tyne.
1896 Oct. 24	PARKER, S. W.	Surveyor to the Urban District Council, Gainsborough.
1893 July 13	PARR, F., Assoc. M. Inst. C.E.	Borough Surveyor, Bridgwater.
G1902 Mar. 22 TA1904 Oct. 29 TAM1909 June 5 T1911 July 29 R1912 Jan. 13	*PARR, J. E., A.M. Inst. C.E.	City Engineer's Department, Council House, Birmingham.
G1893 Jan. 14 T1894 Oct. 20 R1908 Jan. 18	*PARR, N.	Brunswick House, Brentford.
1905 June 22	*PARRY, E.	District Main Road Surveyor, Hertforshire. Lancaster Avenue, Hitchin, Herts.
1913 July 16	*PARRY, J. O.	Saron Post Office, Llandybie, South Wales.
1912 Apr. 27	PARRY, T. R...	Surveyor to the Urban District Council, Barmouth.
G1906 June 28 TAM1909 July 17 T1911 July 29 R1912 Jan. 13	*PARSONS, A. S., A.M.Inst.C.E	City Engineer's Department, Council House, Birmingham.
A1904 Sept. 5 TAM1911 July 29 T1912 Feb. 10	PATERSON, J. B.	Chief Assistant to City Engineer, Dundee.
P1894 June 21	PATON, J. (*Past President. Member of Council.*)	Borough Engineer, Plymouth.
1905 June 22	PATTINSON, N. P.	Borough Surveyor, Gateshead.
1895 Jan. 19	PATTISON, W. P.	Surveyor to the Urban District Council, Benwell and Fenham.

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Date of Election and Transfer.		
1897 Jan. 16	PEACOCK, T. J.	District County Surveyor, Holland County Council, Spalding.
1898 Dec. 17	PEARCE, F. W.	Surveyor to the Urban District Council, Twickenham.
1913 Sept. 6	*PERCIVAL, S. C.	First Assistant to County Surveyor, Northampton.
1912 June 1	PERKINS, R. S. W.	County Surveyor, Southern Division, Isle of Ely.
G1903 Dec. 12 TAM1911 July 29 T1912 Mar. 2	*PERSEY, W. C.	Chief Assistant, Town Hall, Barrow-in-Furness.
1891 Dec. 12	PEIRCE, R., M. Inst. C.E. ..	Municipal Engineer, Singapore, S.S.
A1902 Mar. 22 T1906 Dec. 15	PHILLIPS, G. A., A.M.Inst. C.E. (*Member of Council.*)	County Surveyor, Glamorgan. County Hall, Cardiff. *District Representative*, South Wales District.
1889 May 18 R1908 Jan. 18	PHILLIPS, R., Assoc. M. Inst. C.E.	9 Belgrave Road, Gloucester.
1913 Jan. 4	PHILLIPS, T. A. F.	Chief Assistant, County Surveyor's Office, West Sussex. Horsham.
P1904 May 28	PHIPPS, F. R., Assoc.M. Inst. C.E.	Borough Surveyor, Basingstoke. *Hon. Sec.*, Southern District.
1901 Aug. 24	PICK, S. P.	County Surveyor, Leicester, 6 Millstone Lane, Leicester.
1901 Oct. 19	PICKARD, J. E.	Borough Surveyor, Pontefract, Yorks.
1898 Apr. 23	PICKER, E.	Engineer and Surveyor to the Rural District Council, Beverley.
G1887 June 18 PT1890 Sept. 13	*PICKERING, J. S., M. Inst. C.E. (*Vice-President.*)	Borough Engineer, Cheltenham.
G1894 Jan. 13 T1895 Oct. 19	*PICKLES, G. H., M. Inst. C.E.	Borough Engineer, Burnley.
1906 Mar. 3	PICTON, T. S...	Borough Engineer, Eccles.
G1904 May 28 TAM1911 June 10 T1911 July 29	*PIERCY, M. A.	Deputy Borough Engineer, Warrington.
G1899 Oct. 21 A1904 June 25 AM1908 July 18 T1910 Sept. 17	*PLANT, WM., A.M.Inst.C.E.	Borough Engineer, Stafford.
P1881 Dec. 10	PLATT, S. S., M. Inst. C.E.	Borough Surveyor, Rochdale.
AM1911 Mar. 4 T1911 July 29	POLE, E. C.	Deputy County Surveyor, Glamorganshire. 34 Connaught Road, Cardiff.
1897 July 8	POOLE, H. C.	c/o D. J. Poole, Town Hall, Tiverton, Devon.
G1907 Mar. 2 TAM1911 Mar. 4 T1911 July 29	*POULDEN, G. E. L., A.M.Inst. C.E.	Resident Engineer on Water Supply, c/o Treasurer, Zanzibar.
1899 Jan. 21	POWELL, J.	Town Engineer, East London, Cape of Good Hope.
AM1911 Mar. 4 T1911 July 29	*POWELL, W. G.	City Engineer's Office, Norwich.
1899 Oct. 21	*PRESCOTT, A. E.	Borough Surveyor, Eastbourne.

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Date of Election and Transfer.		
1898 Mar. 19	PRESCOTT, W. H., M. Inst. C.E. (*Member of Council.*)	Surveyor to the Urban District Council, Tottenham, N. *District Representative*, Eastern District.
G1894 June 21 T1899 June 29	*PRICE, A. J.	Surveyor to the Urban District Council, Lytham.
A1910 Jan. 22 TAM1911 July 29 T1912 Feb. 10	*PRICE, D. H.	Surveyor to the Urban District Council, Bedwellty.
1909 Dec. 11	PRIESTLEY, C. H., M.Inst.C.E.	Waterworks Engineer, Cardiff.
AM1910 July 16 T1911 July 29	PRITCHARD, H.	Surveyor to the Rural District Council, Burnley, Lancs.
1904 Sept. 29	PRITTY, J.	Burgh Engineer, Selkirk.
1892 May 28	PROUSE, O. M., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Ilfracombe.
1913 June 21	PUDDICOMBE, W. P.	Engineer and Surveyor to the Urban District Council, Oystermouth. Council Offices, Mumbles, near Swansea.
1913 Jan. 4	PULLEN, E. W.	District Main Road Surveyor, Herts County Council. Invermead, Brampton Road, St. Albans.
1904 Aug. 4	PURDIE, W. H.	Burgh Engineer, Hamilton.
1899 May 6	PURSER, W. B., A.M. Inst. C.E.	County Surveyor, Kesteven County Council. Grantham.
1905 Dec. 9	PUTTEN, E. VAN, M.Inst.C.E.	Borough Engineer, Lewisham. Town Hall, Catford, S.E.
G1904 Dec. 3 TAM1911 July 29 T1911 Sept. 23	QUIRK, J. J.	Surveyor to the Urban District Council, Brynmawr.
A1903 Dec. 12 T1909 Dec. 11	*RACE, A.	Borough Engineer, Barrow-in-Furness.
1886 Dec. 18 R1901 Oct. 19	RADFORD, J. C., A. M. Inst. C.E.	223 Upper Richmond Road, Putney, S.W.
AM1910 May 24 T1911 July 29	RAINE, W. S.	Highway and Building Surveyor, Rural District Council, Hungerford.
A1902 Mar. 22 TAM1907 Dec. 14 PT1911 July 29	RANSOM, W., A. M. Inst. C.E.	Assistant City Surveyor, Worcester.
1889 July 4	RAPLEY, W.	Surveyor to the Rural District Council, Dorking.
1908 May 23	RAWSON, G.	Surveyor to the Urban District Council, Worksop.
G1901 June 8 TAM1911 July 29 T1912 Feb. 10	*READ, F., Assoc.M.Inst.C.E.	Engineer and Surveyor to the Urban District Council, Gellygaer. Council Offices, Hengoed, Glam.
1878 May 1	READ, R., A.M.Inst. C.E. ..	City Surveyor. Gloucester. *Chairman*, Southern District.
G1897 June 19 TA1901 Dec. 7 T1904 Sept. 17	*REDFERN, J. L.	Borough Surveyor, Gillingham, Kent.
1892 Mar. 11	REYNOLDS, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Friern Barnet.

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Date of Election and Transfer.		
G1899 Mar. 25 A1907 Jan. 19 T1910 Mar. 12	*RICHARDS, E. P.	Chief Engineer to the Calcutta Improvement Trust, 5 Clive Street, Calcutta.
1888 July 12 R1902 Feb. 22	RICHARDS, R. W., M. Inst. C.E.	350 George Street, Sydney, N.S.W. *Hon. Corresponding Secretary* for Australasia.
1888 May 12 B1912 Jan. 13	RICHARDSON, H., Assoc. M. Inst. C.E.	Council House, Handsworth, Birmingham.
AM1907 Sept. 7 T1911 July 29	RICHARDSON, H.	Deputy Borough Surveyor, Scarborough.
1884 Oct. 9	RICHARDSON, J.	County Surveyor, Rutland. Stamford.
AM1911 Mar. 4 T1911 July 29	RICHARDSON, J. F., M.A. ..	City Engineer's Office, Oxford.
1901 May 11	*RIDLER, W., A.M. Inst. C.E.	Borough Surveyor, Tewkesbury.
1892 Mar. 11	RIDOUT, A. R.	Surveyor to the Urban District Council, Stone.
1913 Jan. 4	RILEY, G.	Engineer and Surveyor to the Urban District Council, Wellington, Salop.
G1901 Aug. 24 TA1905 Dec. 9 T1906 June 28	*RILEY, J.	Engineer to Irrigation and Water Supply Dept., Pretoria, Transvaal, S.A.
1913 Mar. 15	RIVERS, C. E...	Borough Engineer and Surveyor, Harrogate.
G1891 Dec. 12 T1897 Mar. 13	*ROBERTS, F., A. M. Inst.C.E.	Borough Engineer, Worthing.
AM1910 Dec. 10 T1911 July 29	ROBERTSON, A. S., A.M.Inst. C.E.	City Engineer's Office, Edinburgh.
1912 July 11	ROBERTSON, B.	County Road Surveyor, Inverness, N.B.
A1904 Aug. 5 TAM1910 Dec. 10 T1911 July 29	ROBERTSON, R.	P.W.D., Pretoria, Transvaal, S.A.
1909 Sept. 4	ROBINSON, M. A.	City Engineer, Londonderry, Ireland.
A1906 May 26 TAM1911 July 29 T1912 Apr. 27	ROBINSON, W. P., B.Sc. (Vict.), A. M. Inst. C.E. .	County Surveyor, Devon County Council. The Castle, Exeter.
1876 May 1	ROBSON, O. C., M. Inst. C.E. (*Past President.*)	Engineer to the Urban District Council, Willesden, Middlesex.
G1907 Dec. 14 T1910 Jan. 22	*RODDAN, T. K.	Burgh Surveyor, Broughty Ferry.
1896 Mar. 21	RODWELL, A.	Surveyor to the Rural District Council, Skipton.
1913 Jan. 4	ROGERS, R. A.	Surveyor to the Rural District Council, Newton Abbot, Devon.
1896 Jan. 18	ROGERS, W. E.	Surveyor to the Urban District Council, Rugely.
1912 Dec. 7	ROGERSON, W. A.	District Surveyor, Norfolk County Council. Downham, Norfolk.
1904 Oct. 22	RONALD, D.	Burgh Engineer, Falkirk. *Hon. Sec.*, Scottish District.
1913 Apr. 19	ROSS, G.	Burgh Surveyor, Clydebank.
1895 Jan. 19	ROSS, J. C., A.M. Inst. C.E. ..	Town Surveyor and Engineer to Water Trust, Warrnambool, Victoria.

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Date of Election and Transfer.		
G1903 June 6 A1904 Mar. 26 AM1908 Feb. 29 T1910 Mar. 12	*ROSEVEARE, L., A.M.Inst.C.E.	Borough Engineer, South Shields.
G1901 Feb. 16 T1905 Mar. 3	*ROTHERA, A.	Surveyor to the Urban District Council, Liversedge.
1880 Oct. 2 R1905 May 27	ROUNTHWAITE, R. S., M. Inst. C.E.	4 Willis Street, Wellington, New Zealand.
G1900 Jan. 16 T1909 Feb. 27	*ROUSELL, A. J., A.M.Inst. C.E.	Surveyor to the Urban District Council, Whitley and Monkseaton.
A1902 Nov. 8 TAM1911 July 29 T1912 Feb. 10	ROWBOTTOM, J.	Deputy Borough Surveyor, Ashton-under-Lyne.
1888 May 12	RUCK, F. W.	County Architect, 86 Week Street, Maidstone.
1895 Feb. 16	RUSHBROOKE, T. J.	Borough Surveyor, High Wycombe.
1896 Apr. 25	*RUSHTON, E.	73 Highgate, Cleethorpes.
1912 Oct. 26	RYDER, E. E.	Engineer and Surveyor to the Urban District Council, Bushey.
A1903 Mar. 21 T1904 Sept. 17	RYMAN, F. R., A.M.Inst.C.E.	Borough Surveyor, Stamford.
A1903 June 6 AM1908 Sept. 5 T1910 Oct. 29	SADLER, F.	Engineer and Surveyor to the Urban District Council, Acton.
1890 Mar. 29 R1904 Mar. 26	*SAISE, A. J., Assoc. M. Inst. C.E.	Ventnor House, Forest Road, Fishponds, Bristol.
1899 Feb. 25	SALKIELD, T.	Chief Engineer to the Municipality, Delhi, India.
1913 Apr. 19	SALVIN, T.	Deputy Borough Engineer, Rotherham.
A1903 June 25 T1906 Dec. 15	*SAUNDERS, E. Y.	Borough Surveyor, Barnstaple.
G1887 June 18 T1898 May 21 R1903 Mar. 21	*SAUNDERS, J., A.M. Inst. C.E.	86 Appleton Gate, Newark-on-Trent.
AM1911 June 10 T1911 July 29	*SAUNDERS, R...	Assistant Borough Surveyor, Borough Surveyor's Office, Gravesend.
G1894 Oct. 20 A1902 May 10 TAM1909 Dec. 11 T1911 July 29	*SAVAGE, E. B., A. M. Inst. C.E.	Superintending Engineer, Sewers and Rivers Department, Council House, Birmingham.
1911 June 10	SAVAGE, W. H.	The Grange, Cockfosters, Herts.
1894 Mar. 3	SAVILLE, J.	Town Surveyor, Heckmondwike.
G1906 May 26 TAM1911 July 29 T1912 Feb. 10	*SAWDON, J. S.	Chief Assistant, Borough Surveyor's Office, Margate.
1899 May 6	SCHOFIELD, W. H., A.M. Inst. C.E.	County Surveyor, Lancashire. County Hall, Preston.

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Date of Election and Transfer.		
1894 June 21	SCORGIE, N., M. Inst. C.E. .. (*Member of Council.*)	Borough Surveyor, Hackney, N.E. *Hon. Sec. and District Representative,* Metropolitan District.
1888 Nov. 17	SCOTT, H. H., A.M.Inst.C.E.	Borough Surveyor, Hove.
1880 May 27	SCOTT, R. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bishop's Stortford.
1897 Feb. 13	SCOTT, T.	Highway Surveyor to the Rural District Council. Tadcaster. Aberford, near Leeds.
1904 Aug. 4	SCOTT, T. H	Burgh Surveyor, Inverness.
1912 Sept. 9	*SEELS, G. M...	Assistant Engineer and Surveyor to the Urban District Council, New Malden, Surrey.
1909 Mar. 27	SELLARS, M.	Town Surveyor, Dundalk, Ireland. *Hon. Sec.,* Irish District.
1897 July 8	SENIOR, C. E...	Surveyor to the Urban District Council, Neston, Cheshire.
G1894 July 7 / T1898 Mar. 19	*SETTLE, J. A., A.M.Inst.C.E.	Borough Engineer and Surveyor, Bury, Lancs.
A1902 Nov. 8 / T1907 Mar. 2	*SHACKLETON, W., A. M. Inst. C.E.	Borough Surveyor, Nelson.
1896 Nov. 28	SHARPE, J. E.	Surveyor to the Urban District Council, Cheshunt.
1891 June 6	SHAW, H., M. Inst. C.E. ..	Surveyor to the Urban District Council, Ilford.
1890 June 7 / R1901 Aug. 24	SHAW, J. H.	Surveyor to the Urban District Council, Brownhills, Staffs.
1892 May 28	SHEARD, W. C., Assoc.M. Inst. C.E.	Surveyor to the Urban District Council, New Mills. "Stonelea," New Mills, near Stockport.
G1902 July 10 / TAM1908 Sept. 5 / T1911 July 29	*SHEPHERD, G. G.	Chief Assistant, Engineer's Office, Urban District Council, Ilford.
1891 Oct. 17	SHEPHERD, G. J.	Surveyor to the Rural District Council, Kidderminster.
A1905 May 27 / T1907 May 25	SHERREN, A. O., A.M.Inst.C.E.	Surveyor to the Urban District, Council, Cheriton.
1913 Apr. 19	SHIELD, J. T...	Deputy Borough Engineer, Blackburn.
1892 July 11	SHILLINGTON, H., M.E. ..	Town Surveyor, Lurgan, Ireland.
1912 Dec. 7	SHIMMIN, W. McN.	Engineer and Surveyor, Urban District Council, Failsworth, near Manchester.
1895 Oct. 19	SHIPTON, T. H.	Surveyor to the Urban District Council, Oldbury.
1902 June 7	SIDDALLS, J.	Borough Surveyor, Tiverton.
1887 Oct. 22	SIDDONS, J. M.	Surveyor to the River Nene Commissioners, Oundle.
1896 Jan. 18	SIDWELL, H. T.	Surveyor to the Rural District Council, Rochford. Rayleigh, Essex.
P1887 July 14 / R1898 Oct. 15	*SILCOCK, E. J., M. Inst. C.E.	11 Tothill Street, Westminster.

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Date of Election and Transfer.		
1897 Mar. 13	SILCOCK, H.	Surveyor to the Rural District Council, Blackwell. 67 Westgate, Mansfield.
AM1910 Apr. 23 T1911 July 29	SILLITOE, W. C., A.M.Inst.C.E.	Chief Assistant to Borough Engineer, Ealing, W.
1913 Apr. 19	SILLS, S...	Assistant City Surveyor, Rochester.
1903 Oct. 17	SIMMONS, T. B.	Surveyor to the Rural District Council, Wigton.
1913 Apr. 19	SIMPSON, F. E.	Surveyor to the Urban District Council, Heavitree.
1901 Feb. 16	SIMPSON, H. FARR	County Surveyor, Northern Division, Isle of Ely. Wisbech.
1906 Dec. 15	SIMS, A.	Surveyor to the Rural District Council, Ashford.
AM1907 Sept. 7 T1911 July 29	SIMS, S. B.	Borough Engineer, Hamilton, N.Z.
1890 Sept. 13	SINCLAIR, J. S., A.M.Inst.C.E.	Borough Surveyor, Widnes.
1912 July 11	SINCLAIR, P.	Burgh Surveyor, Buckhaven.
1908 July 18	SINNOTT, E. S., M. Inst. C.E.	County Surveyor, Gloucestershire. Gloucester.
G1905 May 27 TAM1909 Jan. 23 T1911 July 29 B1912 Jan. 13	*SISSONS, F. P.	District Surveyor's Office, Queen Street, Burslem.
1895 Oct. 19	SKELTON, R., A.M. Inst. C.E.	Municipal Engineer, Colombo, Ceylon.
1913 Jan. 4	SKELTON, R. A.	Surveyor to the Rural District Council, Wilton. Bemerton, Salisbury.
G1905 Oct. 28 TAMP1911 July 29 T1912 Feb. 10	*SLATER, E. A., A.M.Inst.C.E.	Deputy Borough Surveyor, Colchester. 201 Malden Road, Colchester.
G1899 Dec. 16 TA1902 May 10 TAM1908 Feb. 29 T1911 July 29	*SLATER, F. J...	Assistant Surveyor, Town Hall, Camberwell, S.E.
1912 Oct. 26	SLAUGHTER, F., A.M.Inst.C.E.	Engineer and Surveyor to the Steyning West Rural District Council.
1898 Oct. 15	SMAIL, J. M., M. Inst. C.E...	Chief Engineer to the Metropolitan Board of Works, Sydney, N.S.W.
G1906 June 28 TAM1908 Sept. 5 T1911 July 29	*SMALL, L. J.	Assistant Surveyor, Council Offices, Woodford Green.
1913 Jan. 4	SMART, F. W.	Chief Engineering Assistant, Bedford County Council. Shire Hall, Bedford.
1895 June 27	SMILLIE, J. F.	Borough Surveyor, Tynemouth.
A1909 June 5 TAM1911 July 29 T1912 Mar. 2	*SMITH, A. E.	Surveyor to the Urban District Council, Hay, via Hereford.
1912 Dec. 7	SMITH, A. J.	Borough Surveyor, King's Lynn.
1892 Mar. 11 B1910 Apr. 29	SMITH, C. CHAMBERS	53 Victoria Street, S.W.
A1904 May 28 TAM1911 July 29 T1912 Feb. 10	*SMITH, C. P.	Assistant Borough Engineer, Town Hall, Greenwich.

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Date of Election and Transfer.		
1902 Sept. 6	SMITH, F. H.	Surveyor to the Urban District Council, Portishead.
G1904 May 28 T1904 Sept. 17	*SMITH, F. HALL	Surveyor to the Urban District Council, Sheringham.
1913 Feb. 8	*SMITH, G.	Surveyor to the Urban District Council, Eton.
A1906 Apr. 28 T1911 June 10	SMITH, H. J. T., A.M.Inst.C.E.	Water Engineer, Bombay.
1899 Mar. 25	SMITH, H. W., A.M. Inst. C.E.	Borough Engineer, Scarborough.
1912 Jan. 13	SMITH, J. D.	County Surveyor, Dalbeattie, Kirkcudbright County Council.
1901 Dec. 7	SMITH, J. GOULD, A.M. Inst. C.E.	Borough Surveyor, Beverley.
1905 Jan. 28	*SMITH, J. H. WOOLSTON, A. M. Inst. C.E.	Surveyor to the Urban District Council, Minehead.
1912 Dec. 7	SMITH, J. S.	Road Surveyor, Kintyre District Council, Campbeltown.
G1898 Dec. 17 TA1901 Oct. 19 T1903 Oct. 17	*SMITH, J. WALKER	Local Government Board of Scotland, George Street, Edinburgh.
1913 July 16	SMITH, M. B.	Engineer to the Shire of Hastings. Shire Chambers, Hastings Shire Council, Wauchope
P1904 Aug. 6	SMITH, P. C.	Burgh Surveyor, Arbroath.
P1891 Dec. 12	SMITH, T. R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Kettering.
1897 Jan. 16	SMITH, V.	Borough Surveyor, Chesterfield
G1888 Jan. 14 T1897 Mar. 13	*SMITH-SAVILLE, R. W., Assoc. M. Inst. C.E.	Borough Surveyor, Darwen.
G1905 Mar. 4 TAMP1911 July 29 T1912 Jan. 13	*SNAPE, A. E., M.Sc., A.M.Inst. C.E.	Professor of Civil Engineering, South African College, Cape Town, S.A.
A1907 Jan. 19 TAM1907 Nov. 2 T1911 July 29	SNODGRASS, R., A.M.Inst.C.E.	147 Fifth Street West, North Vancouver, B.C.
1912 Sept. 9	*SNOOK, H. V.	Surveyor to the Urban District Council, Haslemere.
AM1908 Dec. 5 T1911 July 29	SOUTHWART, J.	Surveyor to the Urban District Council, Rothwell, near Leeds.
1903 Oct. 17	SOWDEN, M.	Surveyor to the Urban District Council, Whitchurch, Salop.
1913 Feb. 8	SPENCE, N. F.	Engineer and Surveyor, Rural District Council, Hartshorne and Seals. Burton Road, Ashby-de-la-Zouche.
1898 Dec. 17	SPENCER, J.	Surveyor to the Urban District Council, Oakworth. York Chambers, Cooke Street, Keighley.
1873 May 2 B1881 Dec. 10	SPENCER, J. P., A.M.Inst.C.E.	30 Howard Street, North Shields.
1902 May 10	SPENCER, L. G. P., A.M. Inst. C.E.	Borough Engineer, Te Kuiti, New Zealand.
1912 Apr. 27	SPITTALL, R.	County Road Surveyor, Middle Ward, Lanarkshire County Council. Hamilton.
1913 Feb. 8	SPREADBOROUGH, H.	Town Surveyor, Youghal, Co. Cork.

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Date of Election and Transfer.		
G1899 Dec. 16 TA1901 Oct. 19 T1904 July 14	*SPRECKLEY, J. A., Assoc. M. Inst. C.E.	Borough Surveyor, Ludlow.
A1901 Dec. 7 T1908 May 23	SPURR, F. W...	City Engineer, York.
A1904 May 28 T1906 Nov. 3	SPURRELL, E. F.	Borough Surveyor, Holborn.
1880 Feb. 7 R1899 June 10	STAINTHORPE, T.W., A.M.Inst. C.E.	P.W.D., Irrigation Department, P.O. Box 399, Pretoria, South Africa. *Hon. Sec.*, African District.
1889 Dec. 14	STALLARD, S., A.M. Inst. C.E.	County Surveyor, Oxfordshire. Oxford.
1913 Apr. 19	*STANLEY, G.	Chief Assistant Engineer to Director of Public Works, Sierra Leone.
G1895 Jan. 19 A1901 Oct. 19 AM1907 Nov. 2 T1910 Apr. 23	*STEELE, W. J.	City Engineer, Newcastle-on-Tyne.
1911 Apl. 29	STEPHENS, R.	District Surveyor, Chard Rural District Council, Ilminster.
1892 Mar. 11	STEPHENSON, E. P., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno.
1892 Mar. 11	STEVENSON, A.	County Road Surveyor, Ayrshire County Council. Ayr.
1913 Mar. 15	STEVENSON, G. H.	Highway Surveyor, Rural District Council, Shifnal. "Mardu," Shifnal.
1891 Oct. 17	STEVENSON, J.	Surveyor to the Urban District Council, East Molesey.
1913 Mar. 15	STEWARD, D. H.	Main Road Surveyor, Norfolk County Council. Aylsham, S.O., Norfolk.
1901 Feb. 16	STEWART, J.	Borough Engineer, Dunstable. Beds.
AM1908 Apr. 25 T1911 July 29	STEWART, R. T.	Engineer, Rural District Council, Aylesbury.
1891 June 25	STICKLAND, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Windsor.
1897 Jan. 16	STILGOE, H. E., M.Inst.C.E. (*Member of Council*)	City Engineer, Birmingham.
1900 Dec. 15	STIVEN, E. E.	Borough Surveyor, Whitehaven.
1904 Jan. 23	*STONES, J.	Surveyor to the Rural District Council, Sedgfield, co. Durham.
1913 Jan. 4	STORRAR, J.	Road Surveyor, Suburban District, Midlothian County Council. Edinburgh.
1913 Apr. 19	STRANGE, H. D.	Borough Engineer, Dorchester.
1910 Sept. 17	*STRICKLAND, W.	District Surveyor, Ramsbury Rural District Council, Wilts.
1880 May 27	STUBBS, W., A.M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Blackburn. *District Representative*, North-Western District.
AM1911 June 10 T1911 July 29	*SUGARS, W.	Engineer and Surveyor, Urban District Council, Horbury.
G1892 July 11 T1892 Sept. 24	*SUMNER, F., M. Inst. C.E. ..	City Engineer, Guildhall, London, E.C.

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Date of Election and Transfer.		
G1907 Jan. 19 T1907 May 25	*SUNDERLAND, C. H.	Surveyor to the Urban District Council, Midsomer Norton.
1895 Mar. 16	*SURTEES, R. T.	Water Engineer to the Urban District Council, Newton-in-Makerfield. Newton-le-Willows, Lancs.
A1903 Mar. 21 TAM1908 Sept. 5 T1911 July 29	SUTCLIFFE, H.	Deputy Borough Engineer, Huddersfield.
1909 Sept. 4	SUTCLIFFE, J., A.M. Inst. C.E.	Borough Surveyor, Deptford, S.E.
G1904 May 28 TAM1908 May 23 T1911 July 29	*SUTHERLAND, D. S.	Chief Assistant Surveyor, Southgate.
1904 Aug. 10	SUTHERLAND, J. R., M. Inst. C.E.	Chief Engineer, Water Department, City Chambers, Glasgow.
G1899 June 29 T1901 June 27	*SWALES, T. B.	Borough Surveyor, Maldon.
A1905 Sept. 23 TAM1907 Nov. 2 T1911 July 29	SWARBRICK, G.	Deputy Borough Surveyor, Swansea.
1880 June 23 B1889 Apr. 13	SWARBRICK, J., M. Inst. C.E.	30 St. Anns Street, Manchester.
AM1910 Apr. 23 T1911 July 29	*SWINSTEAD, E. W.	Assistant Surveyor, Western Division, Town Hall, St. Pancras.
1899 June 10	SYKES, M. H.	Borough Surveyor, Stockton-on-Tees.
G1902 Feb. 22 TA1904 Dec. 3 T1906 Nov. 3	*TAIT, W. L., A.M. Inst. C.E.	Borough Engineer, Sudbury, Suffolk.
1887 Mar. 12	TANNER, W.	County Surveyor, Monmouthshire. Newport.
1891 Mar. 21 B1903 Mar. 21	TAYLOR, H. W., Assoc. M. Inst. C.E.	Cathedral Buildings, Dean St., Newcastle-on-Tyne.
G1898 Dec. 17 TA1902 Jan. 25 T1907 Sept. 7	*TAYLOR, J.	Borough Engineer, Walsall.
G1900 Dec. 15 TA1903 May 16 T1907 May 25	*TAYLOR, P.	Surveyor to the Urban District Council, Hampton Wick.
1913 Feb. 8	TAYLOR, R. J.	District Main Road Surveyor, Bedfordshire C.C. 1 Kingsley Road, Bedford.
1890 Sept. 13	TAYLOR, T. G.	Borough Surveyor, Ramsgate.
1909 Feb. 27	TAYLOR, W. H.	Surveyor to the Urban District Council, Aylesbury.
G1891 Sept. 12 T1897 Oct. 16	*TAYLOR, W. J., M. Inst. C.E.	County Surveyor, Hants. Winchester.
1912 Dec. 7	TEBBITT, H. S.	Engineer and Surveyor, Rural District Council, Tutbury, Staffs.
1892 Apr. 23	TERRILL, W.	Surveyor to the Urban District Council, Ashford, Kent.

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Date of Election and Transfer.		
G1899 June 10 TA1905 Sept. 23 TAM1911 July 29 T1912 Feb. 10	*Thackeray, J. R.	Deputy Borough Surveyor, Eastbourne.
G1907 June 20 TA1907 Nov. 2 TAM1911 July 29 T1912 Mar. 2	*Thackray, F. J.	Surveyor to the Urban District Council, Hoyland Nether.
1892 Mar. 11	*THOMAS, R. J., M. Inst. C.E. (*Past President.*) (*Member of Council.*)	County Surveyor, Buckinghamshire. Aylesbury.
1890 May 3	Thomas, T. J., A.M.Inst.C.E.	Surveyor to the Urban District Council, Ebbw Vale.
1902 May 10	Thomas, W. B.	Surveyor to the Urban District Council, Southwick-on-Wear.
1887 Sept. 17	Thomas, W. E. C., A.M. Inst. C.E.	Surveyor to the Rural District Council, Neath.
1913 May 24	Thompson, G. W.	Engineer and Surveyor to the Urban District Council, Hipperholme, Yorks.
A1904 June 25 TAM1911 July 29 T1912 Feb. 10	*Thompson, W., Assoc.M.Inst. C.E.	Deputy Borough Engineer, Burton-on-Trent.
1906 Nov. 3	Thomson, J.	City Engineer, Dundee.
G1904 June 25 T1906 Nov. 3	*Thorp, W. O.	Surveyor to the Urban District Council, Malvern.
1891 Jan. 21	Thorpe, J.	Surveyor to the Rural District Council, Macclesfield.
1898 Jan. 15	Thropp, J., M. Inst. C.E. ..	County Surveyor, Lincolnshire. 29 Broadgate, Lincoln.
1913 Feb. 8	Thwaites, D. C.	Assistant Borough Engineer and Surveyor, Ossett.
G1898 June 30 T1903 Dec. 12	*Tiffin, T. E., A.M.Inst.C.E.	Surveyor to the Urban District Council, Dartford, Kent.
1913 Sept. 6	Tillstone, H.	Borough Surveyor, Brighton.
1913 Jan. 4	Tipple, A. C.	Deputy Borough Engineer and Surveyor, Halifax.
G1891 June 6 T1893 Oct. 21	*Tomes, G. B., A.M. Inst. C.E.	Surveyor to the Urban District Council, Barnes, Mortlake.
G1902 July 10 AM1908 Apl. 25 T1910 Sept. 17	*Tomlinson, J. W.	Borough Engineer, Luton.
1895 Mar. 16	Tooley, H.	Surveyor to the Urban District Council, Buckhurst Hill, Essex.
1890 May 3	Towlson, S., A.M. Inst. C.E.	Surveyor to the Urban District Council, Sevenoaks.
G1900 June 16 TAM1907 Sept. 7 T1911 July 29	*Towner, H. V., A.M.Inst.C.E.	Executive Engineer, P.W.D., Singapore.
1894 Oct. 20	Travers, W. H.	Borough Engineer and Surveyor, Wallasey.
1913 Feb. 8	Treadwell, J. R.	Highway Surveyor, Rural District Council, Easthampstead. Council Offices, Brocknell.
G1900 June 16 T1910 Dec. 10	*Tremelling, H., A. M. Inst. C.E.	Borough Engineer, Newport, Mon.
1912 June 1	Triffitt, C.	Deputy City Surveyor, York.

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Date of Election and Transfer.		
1901 Feb. 16	TROWSDALE, T. J.	Surveyor to the Urban District Council, Annfield Plain. Hare Law, Annfield Plain, Co. Durham.
AM1909 Dec. 11 T1911 July 29	TRUSLER, G. D.	City Engineer's Office, Guildhall, E.C. The Downs, Beeches Avenue, Carshalton.
1893 Oct. 21	TURLEY, A. C., A.M.Inst.C.E.	City Engineer, Canterbury.
AM1910 Mar. 12 T1911 July 29	TURNER, F., B.Sc.Eng. (Lond.), A.M. Inst. C.E.	Borough Engineer, Morley.
1899 June 10	*TURNER, S.	Surveyor to the Rural District Council, Ashby-de-la-Zouche.
1898 June 30	TURRIFF, A. A.	Burgh Surveyor, Elgin.
1905 May 27	*UREN, F. C., M. Inst.C.E.I. ..	Surveyor to the Urban District Council, Aldershot.
G1911 June 10 TAM1911 July 29 T1912 Apr. 27	*VANSTONE, F. W. E.	2 Palace Chambers, Paignton.
AM1911 Apr. 29 T1911 July 29	*VAWSER, C., A.M.Inst.C.E.I.	County Surveyor's Office, Hatfield, Herts.
G1894 Jan. 13 T1901 Dec. 7 R1903 Feb. 21	*VEIT, L. J.	1 Pimlico Road, S.W.
1889 Sept. 21 R1903 Jan. 17	VENTRIS, A., Assoc. M. Inst. C.E.	Westminster City Hall, W.C.
AM1911 Apr. 29 T1911 July 29	VINCENT, E. E. L., A.M.Inst. C.E.	Surveying Assistant, Port of London Authority. 44 Caterham Road, Lewisham, S.E.
1897 June 19	VINCENT, S. J. L., A.M. Inst. C.E.	Borough Surveyor, Newbury.
1913 Mar. 15	WADDELL, J. A.	Burgh Surveyor, Burntisland.
1911 Apl. 29	WADDINGHAM, T.	Engineer and Surveyor to the Urban District Council, Hebden Bridge.
1894 June 21	WADDINGTON, J. A. P., M.Inst. C.E.	Borough Engineer, Marylebone, W.
AM1910 Oct. 29 T1911 July 29	WAINWRIGHT, W. H., A.M.Inst. C.E.	City Engineer's Office, Edinburgh.
1907 Dec. 14	*WAITHMAN, C. H...	Surveyor to the Urban District Council, Town Hall, Cleethorpes, Lincs.
1902 June 7	WAKEFORD, J. P., A. M. Inst. C.E.	City Surveyor, Wakefield. *Hon. Secretary*, North-Eastern District.
1888 July 12	WAKELAM, H. T., M. Inst. C.E. (*Vice-President.*) ..	County Engineer, Middlesex. 63 Victoria Street, Westminster, S.W. *Chairman*, Eastern District.
1898 Sept. 3	WALKER, A. H., A. M. Inst. C.E.	Borough Surveyor, Loughborough.

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Date of Election and Transfer.		
G1900 Dec. 15 T1904 Jan. 23	*WALKER, H.	Surveyor to the Urban District Council, Wealdstone.
1913 June 21	WALKER, J. S.	Deputy Borough Engineer and Surveyor, Wallasey.
1913 Apr. 19	WALLINGFORD, A. C.	County Surveyor, Soke of Peterborough. Peterborough.
1887 June 18	WALSHAW, J. W.	Borough Surveyor, Peterborough.
1912 July 11	WALTERS, J. R.	Borough Surveyor, Congleton.
G1904 May 28 TA1904 Dec. 3 TAM1907 Dec. 14 T1911 Jan. 21	*WALTON, J. S.	Borough Engineer, Falmouth.
1905 Sept. 23	WARBURTON, W. E.	Surveyor to the Urban District Council, Hornsea.
A1905 Sept. 23 TAM1909 June 5 T1911 July 29	WARD, A. W., A.M. Inst. C.E.	Deputy Borough Engineer, Stockport.
1899 Jan. 21	WARD, J., M. Inst. C.E. ..	Borough Engineer, Derby.
1886 July 8 R1912 Jan. 13	WARDLE, J. W., A.M.Inst.C.E.	341 Uttoxeter Road, Longton, Stoke-on-Trent.
G1904 May 28 T1904 Sept. 17	*WARR, G. W.	Surveyor to the Urban District Council, Southwick.
1890 May 3	WATERHOUSE, D.	Surveyor to the Urban District Council, Watford.
1913 Mar. 15	WATFORD, P. A.	Surveyor to the Rural District Council, Claypole. 18 Milner Street, Newark-on-Trent.
1913 Mar. 15	WATSON, C.	Surveyor to the Urban District Council, Ambleside.
1912 Apr. 27	WATSON, J.	County Road Surveyor, Middle Ward, Lanarkshire County Council. Strathaven.
1887 June 18	WATSON, J. D., M. Inst. C.E.	Engineer to the Birmingham, Tame and Rea Drainage Board, Tyburn, near Birmingham.
AM1909 July 17 T1911 July 29	*WATSON, R. H. H.	County Engineer's Office, Reading.
1904 Aug. 10	WATSON, W.	Burgh Surveyor, St. Andrews.
1889 Sept. 21	WATTS, E. T.	Surveyor to the Rural District Council, Hadham and Stansted, Bishop's Stortford.
1909 July 17	*WATTS, T. N. W.	Surveyor to the Urban District Council, Marlow.
1897 Feb. 13	WEBB, J. A.	Surveyor to the Rural District Council, Hendon. Great Stanmore. *Hon. Sec.*, Eastern District.
1901 Oct. 19	WEBSTER, J. W.	Surveyor to the Urban District Council, Cowes, Isle of Wight.
1905 Jan. 28	WEBSTER, R. A.	Town Engineer, Krugersdorp Transvaal, S.A.
1913 Mar. 15	WEEBER, F.	Surveyor to the Urban District District Council, Horncastle.
G1899 June 10 TA1902 Mar. 2 T1911 Jan. 21	*WEIR, J. S., A.M.Inst.C.E. ..	Borough Engineer, Jarrow-on-Tyne.

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Date of Election and Transfer.		
1882 Apr. 15	WELBURN, W.	Borough Surveyor, Middleton, near Manchester.
1912 Dec. 7	*WELLSTED, C. G.	Deputy Engineer, Sculcoates Rural District Council. Waterloo Chambers, Hull.
1887 June 18 R1903 Feb. 21	WESTON, G.	The Limes, Harrow Road, Pinner.
1889 Apr. 13 R1903 Jan. 17	WESTON, H. J., Assoc. M. Inst. C.E.	24 Portland Street, Southampton.
1907 May 25	WHEELER, A. G.	Surveyor to the Urban District Council, Eastwood.
P1888 July 12	WHITE, A. E., M. Inst. C.E. ..	City Engineer, Hull.
G1902 Jan. 25 TAM1911 July 29 T1911 Oct. 21	*WHITE, C. D.	Surveyor to the Urban District Council, Newton Abbot.
AM1909 June 5 T1911 July 29	WHITE, H. A.	Engineer's Office, Town Hall, Battersea.
1900 Mar. 10	WHITE, J. N.	Borough Surveyor, Stalybridge.
1873 May 2	WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
A1903 May 16 TAM1911 July 29 T1912 Feb. 10	WHITE, W. H. J., Assoc.M. Inst.C.E.	Deputy Borough Engineer, Town Hall, Cheltenham.
1912 Feb. 10	WHITEHEAD, H. O.	Chief Assistant, Boro' Engineer's Office, Southend-on-Sea.
A1909 June 5 TAM1911 July 29 T1912 June 1	*WHITEHEAD, S.	Water Engineer and Manager, Nelson, Lancs.
1910 Oct. 29	WHITFEILD, A. G...	Chief Sanitary Engineer, P.W.D., Secoondee, Gold Coast.
1912 Apr. 27	WHITWELL, E.	Surveyor to the Urban District Council, Abersychan.
1900 Aug. 25	WHYATT, H. G., M.Inst.C.E.	Borough Engineer, Great Grimsby. *Hon. Sec.*, East Midland District.
1889 Feb. 9	WIKE, C. F., M. Inst. C.E. .. (*Member of Council.*)	City Surveyor, Sheffield.
1888 May 12	WILD, G. H.	Surveyor to the Urban District Council, Littleborough, near Manchester.
1896 Apr. 25	WILDING, J.	Surveyor to the Urban District Council, Runcorn.
1910 May 24	WILDS, R.	Engineer and Surveyor to the Urban District Council, Walton-on-Thames.
1905 June 22 R1911 Apr. 29	WILES, J. W.	1 Eltop Avenue, Errwood Road, Levenshulme, Manchester.
1912 Sept. 9	WILKES, J. E., A.M.Inst.C.E.	Town Planning Engineer, City Chambers, Dunfermline.
G1902 July 10 TAM1908 Feb. 29 T1911 July 29	*WILKINSON, F., A.M.Inst C.E.	Deputy Borough Engineer. Wimbledon, S.W.
1911 Sept. 23	*WILKINSON, Fred	Engineer and Surveyor, Urban District Council, Prestatyn.
1884 May 29 R1902 Nov. 8	WILKINSON, J. P., M. Inst. C.E.	301–304 Corn Exchange Chambers, Cathedral Street, Manchester.

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Date of Election and Transfer.		
1899 Mar. 25	Wilkinson, M. H.	Surveyor to the Urban District Council, Leyland.
1884 Oct. 9 R1885 June 6	Willcox, J. E., M. Inst. C.E.	63 Temple Row, Birmingham.
A1902 Mar. 22 T1909 July 17	Williams, H. B.	Borough Engineer, Workington.
A1902 July 10 TAM1909 Sept. 4 T1911 July 29	Williams, J.	Deputy Borough Surveyor, Hampstead.
1893 July 31	Williams, J. B.	Borough Surveyor, Daventry.
G1901 Dec. 7 TA1906 Dec. 15 TAM1911 July 29 T1912 Feb. 10	*Williams, J. H.	Deputy Borough Engineer, Todmorden.
A1906 Apr. 28 TAM1909 Mar. 27 T1911 July 29	Williams, S. G., A.M. Inst. C.E.	Resident Engineer, Water Department, Municipal Engineer's Office, Singapore, S.S.
1907 Mar. 2	Williams, T. T.	Surveyor to the Rural District Council, Swansea.
G1898 June 30 A1901 Dec. 7 T1908 Feb. 29	*Willis, E., A.M. Inst. C.E...	Surveyor to the Urban District Council, Chiswick.
1913 Apr. 19	Willis, E. J...	Assistant Surveyor to the Urban District Council, East Barnet.
1891 June 25	Willmot, J.	County Surveyor, Warwickshire. 6 Waterloo Street, Birmingham.
1898 June 30	Wilson, A.	County Surveyor, Dumbartonshire.
G1898 June 30 TA1901 Dec. 7 TAM1908 Sept. 5 T1911 July 29	*Wilson, F., A.M. Inst. C.E...	District Engineer, City Engineer's Office, Bristol.
1873 May 2 R1899 Feb. 25	Wilson, J.	Bankside, Bacup, Lancashire.
1912 Apr. 27	Wilson, J.	County Road Surveyor, East Berwickshire. Reston.
1884 May 29	*Wilson, J. B., A.M. Inst. C.E.	Surveyor to the Rural District Council, Cockermouth.
1912 Sept. 9	Wilson, R. E.	Engineer and Surveyor to the Urban District Council, Knaresborough.
1907 Apr. 27	Wilson, W.	Town Surveyor, Portadown, Ireland.
1880 Oct. 2	Winship, G., A.M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
1896 Feb. 22	Winter, O. E., M. Inst. C.E. *(Member of Council.)*	Borough Surveyor, Hampstead, N.W. *District Representative*, Metropolitan District.
1912 Jan. 13	Winterbottom, R. H. ..	Surveyor to the Urban District Council, Irlam, Lancs.
1913 Mar. 15	*Witts, J. W...	Chief Engineering Assistant, City Engineer's Office, Leeds.
G1900 May 19 TA1902 Jan. 25 T1902 Nov. 8	*Wolfenden, B. J., A.M. Inst. C.E.	Borough Engineer, Bootle.
1894 Mar. 3	Wood, F. J., A. M. Inst. C.E.	County Surveyor, Sussex East. Lewes.

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Date of Election and Transfer.		
AM1909 Feb. 27 T1911 July 29	*WOOD, H. C.	Surveyor, Rural District Council, Tadcaster.
1898 Apr. 23	WOOD, W. E...	Surveyor to the Urban District Council, Church.
1885 Oct. 3 R1903 Feb. 21	WOODBRIDGE, C. A.	Minafon, Hatch End, Middlesex.
1913 June 21	WOODCOCK, W. S...	Highway Surveyor to the Rural District Council, Oakham. Mill Street, Oakham, Rutland.
A1910 Dec. 10 TAM1911 July 29 T1913 Mar. 15	*WOODHALL, P. C.	Borough Surveyor, Blandford, Dorset.
1899 May 6	WOODWARD, F.	Surveyor to the Urban District Council, Stourbridge.
1913 Apr. 19	WORDEN, F. J.	Borough Engineer, Okehampton.
1912 Dec. 7	WORMLEIGHTON, B. J.	Engineer and Surveyor, Urban District Council, Loftus, Yorks.
1897 July 8	*WORRALL, E.	Surveyor to the Urban District Council, Stretford, Council Offices, Old Trafford.
1886 July 8	WORTH, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
G1893 July 13 T1899 Oct. 21 R1904 Dec. 3	*WRIGHT, J. A.	6 Unity Street, Bristol.
1910 Oct. 29	*WRIGHT, W.	Borough Surveyor, Grantham.
1913 Feb. 8	WRIGHT, W.	Municipal Engineer, Lagos, S. Nigeria, W. Africa.
G1906 June 28 T1908 Sept. 5	*WRIGLEY, G. E.	Borough Engineer and Surveyor, Banbury.
1892 May 28 R1908 Jan. 18	WYNNE-ROBERTS, R.O., M.Inst. C.E	P.O. Box 65, Regina, Sask., Canada.
1913 Apr. 19	WYRILL, R. H.	Borough Engineer, Swansea.
1895 Jan. 19	YABBICOM, T. H., M.Inst. C.E. (*Past President.*)	Consulting Engineer, Bristol Corporation, 63 Queen Square, Bristol.
G1891 Aug. 1 TA1901 Oct. 19 TAM1908 Sept. 5 T1911 July 29	*YARWOOD, H...	Assistant Borough Surveyor, Rochdale.
G1892 July 11 T1892 Sept. 24	*YATES, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.
G1901 June 8 TA1902 Feb. 22 TAM1908 Sept. 5 T1911 July 29	*YELLAND, T.	Deputy Borough Engineer, Bury, Lancs.

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Date of Election and Transfer.		
1912 Jan. 13	YONEMOTO, S.	City Engineer, Tokio, Japan.
1894 June 21	YORK, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Barnet Valley. Station Road, New Barnet.
1904 Aug. 26	YOUNG, C.	Burgh Surveyor, Coatbridge.
P1900 May 19	YOUNG, J.	Burgh Surveyor, Ayr.
1899 Dec. 16	YOUNG, T.	Surveyor to the Rural District Council, Sunderland.
1900 May 19	YOUNG, W. P...	Surveyor to the Rural District Council, Walsall.
1908 Sept. 5	YOUNGER, J.	Engineer, P.W.D., Bulawayo, Rhodesia.

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ASSOCIATE MEMBERS.

[A.M.Inst.M.&Cy.E.]

* *Those Associate Members against whose name a star is placed have passed the examination and hold the Testamur of the Institution.*
R *signifies re-election under By-law 6.*
G *elected as Graduate.* A *elected as Associate.*
TA *transferred to Associate.* TAM *transferred to Associate Member.*

Date of Election and Transfer.		
1912 Dec. 7	*Acton, W. B.	Overseer, P.W.D., Nairobi, British East Africa.
1912 Dec. 7	*Anderson, H.	Engineering Assistant, Guildhall, York.
G1906 Apr. 28 TAM1911 July 29	*Andrews, S. H.	Town Hall, Bermondsey, S.E.
1912 Dec. 7 R1913 Sept. 6	*Archer, B.	132 Westfield Road, Wellingborough.
A1901 Oct. 19 TAM1911 July 29	Ashbee, W.	Divisional Surveyor, Middlesex C.C. Briarside, Hanwell, W.
1913 Sept. 6	Atkinson, G.	Engineering Assistant to Borough Engineer, Dewsbury.
1912 June 1	Ballard, G. A.	Engineering Assistant to City Engineer, York.
1912 Dec. 7	*Bannerjee, K. C.	Assistant Engineer, Calcutta Improvement Trust. c/o Messrs. Thos. Cook & Son, Calcutta, India.
G1905 June 22 TA1908 Sept. 5 TAM1911 July 29 R1912 Jan. 13	*Barker, H. W., A.M. Inst. C.E.	Special Engineer's Office, Napier Park, Madras.
A1909 Jan. 23 TAM1911 July 29	*Barlow, A., A.M.Inst.C.E...	City Engineer and Surveyor, Town Hall, Ripon.
1913 Mar. 15	Barnes, J. J...	Engineering Assistant, County Hall, Lewes.
G1890 Mar. 29 TAM1911 July 29	*Bayley, G. H., A.M.Inst.C.E.	19 Cooper Street, Manchester.
1913 Mar. 15	Bedford, E. J. P.	Assistant Surveyor, Urban District Council, Cleckheaton.
G1906 Dec. 15 TA1908 Feb. 29 TAM1911 July 29	*Bell, G. H.	Borough Surveyor's Office, Swansea.
1912 Jan. 13	Bennett, E. H.	Engineering Assistant, Borough Surveyor's Office, Derby.
1911 Sept. 23	*Bennett, M. B.	Town Hall, Hove.
1913 Jan. 4	Bennett, S. C.	Assistant Engineer, Herts County Council. County Surveyor's Office, Hatfield.

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Date of Election and Transfer.		
G1906 May 26 TAM1911 July 29	*Bentley, W.	468 St. Helens Road, Bolton, Lancs.
G1902 Mar. 22 TAM1911 July 29	*Berrington, E. E. W.	Bank Buildings, Lichfield Street, Wolverhampton.
G1903 Dec. 12 TAM1911 July 29	*Biker, W. J. E.	Baynes Lake, British Columbia.
G1900 June 16 TA1908 June 25 TAM1911 July 29	*Blakeway-Phillips, R. ..	City Engineer's Office, Westminster City Hall, W.C.
G1889 June 8 TAM1911 July 29	*Blizard, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton
1913 Apr. 19	Bonn, W.	Assistant Surveyor, County Road Surveyor's Office, 14 Cathcart Street, Ayr.
A1903 Jan. 17 TAM1911 July 29	*Booth, E. W., A.M.Inst.C.E.	25 Cross Street, Manchester.
1913 Feb. 8	Booth, J. A.	Assistant Engineer, Water Engineer's Department, City Chambers, Glasgow.
1911 Dec. 2	*Bose, N. N.	65/4 College Street, Calcutta, India.
1913 May 24	Box, A. C.	Engineering Assistant, Surveyor's Office, Staines Rural District Council.
1913 June 21	*Boydell, F. L.	Engineering Assistant to Borough Engineer, Leigh, Lancs.
G1892 Oct. 15 TAM1911 July 29	*Bradshaw, J. B., A.M.Inst. C.E.	Royal Engineer's Office, Weymouth.
1913 Jan. 4	Bradshaw, T.	Chief Inspector's Assistant, Thames Conservancy Board, London. "East View," Lent Rise, Taplow, Bucks.
1912 Jan. 13	*Braggins, A. D.	Assistant Surveyor, Urban District Council, Newquay.
1912 June 1	*Bright, C. D.	Sanitary Inspector, Cosford Rural District Council, Palstead Heath, Colchester.
A1903 July 25 TAM1911 July 29	*Bromly, A., A.M. Inst. C.E.	Assistant Engineer, Town Hall, Croydon.
G1908 July 18 TA1909 Dec. 11 TAM1911 July 29	*Brothers, L. D.	Borough Surveyor's Office, Blackburn.
1912 Jan. 13	Brown, A. W. D.	Shire Engineer, Swan Hill, Victoria, Australia.
A1908 June 25 TAM1911 July 29	*Brown, H. B. E., A.M.Inst. C.E.	Borough Engineer's Office, Northampton.
A1909 June 5 TAM1911 July 29	*Brown, J. W. E.	Borough Surveyor's Office, Burnley.
1913 June 21	Brown, T. M.	Burgh Surveyor, Denny.
G1889 July 4 TAM1911 July 29	*Bryans, J. G., A.M.Inst.C.E.	277 Calle 25 de Mayo, Buenos Ayres.
G1905 May 27 TA1908 July 18 TAM1911 July 29	*Bull, E. M., A.M.Inst.C.E.	Council Offices, Finchley.

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Date of Election and Transfer.		
G1899 June 29 TAM1911 July 29	*Burgess, R. W.	Town Hall, Stratford, E.
G1905 June 29 TAM1911 July 29	*Butler, R.	21 Hazleton Avenue, Toronto, Canada.
PG1904 June 25 TAM1911 July 29	*Butt, E. E. W.	Council Offices, Birmingham.
1913 Feb. 8	Campbell, R. A.	Resident Engineer, Water Engineer's Department, City Chambers, Glasgow.
1912 Mar. 2	*Cardell, J. E.	District Surveyor, Hunts C. C., Paxton Manor, St. Neots, Hunts.
A1904 Sept. 1 TAM1911 July 29	Carson, W. H., Assoc. M. Inst. C.E.	District Engineer for the Province of Ontario. Marine Dept., Ottawa, Canada.
G1897 June 19 TAM1911 July 29	*Cartledge, J. R.	Assistant Surveyor, District Council Offices, Barnes, S.W.
G1906 May 26 TAM1911 July 29	*Castle, J. H...	Engineering Assistant, Town Hall, Bedford.
1913 June 21	Caulfeild, R. W. St. G. ..	Executive Engineer, P.W.D., Kedah Government, Malay States.
G1908 June 25 TAM1911 July 29	*Chapman, H. J.	Borough Surveyor's Office, 81 High Street, Buckingham.
G1908 June 25 TAM1911 July 29	*Charles, J. A.	Borough Engineer's Office, Barrow-in-Furness.
A1909 Jan. 23 TAM1911 July 29	*Clark, A.	Assistant Engineer, Rural District Council, Town Hall, Croydon.
G1904 Dec. 3 TAM1911 July 29	*Clarke, R. E.	Public Offices, Arnold, Notts.
1913 June 21	*Clibbens, A...	Engineering Assistant to City Engineer, Bristol.
1913 Mar. 15	Coates, F. G.	Assistant Engineer, Town Hall, Sandown, Isle of Wight.
1913 Apr. 19	Coburn, F. S.	Engineering Assistant, Town Hall, Leicester.
G1903 Dec. 12 TAM1911 July 29	*Cochrane, J.	Water Engineer's Office, City Chambers, Glasgow.
1912 June 1	*Cockrill, O. H.	Borough Surveyor's Office, Gt. Yarmouth.
1912 Feb. 10	Cole, A. V., A.M.Inst.C.E...	Borough Engineer's Office, Town Hall, Nelson.
G1911 Jan. 21 TAM1911 July 29	*Coles, A.	Bloomfield House, Peasedown, St. John, Bath.
1913 Jan. 4	Collins, W. R.	Engineering Assistant, Public Offices, Enfield.
A1904 Oct. 11 TAM1911 July 29	Connor, C.	c/o John Mowlem & Co., Grosvenor Wharf, S.W.
G1906 May 26 TA1908 Sept. 5 TAM1911 July 29	*Conway, F. J. K.	Pearl Assurance Buildings, St. John's Lane, Liverpool.

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Date of Election and Transfer.		
G1900 May 19 TA1901 Oct. 19 TAM1911 July 29	*COOMBS, C. A.	Irrigation Works, Trincomalee, Ceylon, India.
1912 Sept. 9	COOPER, L. A.	Engineer and Surveyor's Office, Town Hall, Chiswick.
G1906 Dec. 15 TAM1911 July 29	*COUZENS, B. H.	City Engineer's Office, York.
G1904 May 28 TAM1911 July 29	*COWLISHAW, H. H.	Chez Nous, Gander Green Lane, Sutton, Surrey.
G1904 Jan. 23 TAM1911 July 29	*COX, C. E.	Hill View, Clent, near Stourbridge.
G1892 July 11 TAM1911 July 29	*CROSS, F. W., A.M. Inst. C.E.	Humberstone, Lichfield Road, Sutton Coldfield.
G1907 May 25 TA1908 Sept. 5 TAM1911 July 29	*CROSSLEY, H. B.	Engineering Assistant, Council Offices, Acton.
G1903 June 6 TAM1911 July 29	*CUBITT, H. W.	227 Strand, W.C.
A1909 Dec. 11 TAM1911 July 29	*CUNLIFFE, I.	Surveyor's Office, Town Hall, Withington, Manchester.
G1911 June 10 TAM1911 July 29	*CURRIE, A. W.	Town Hall, Milton Road, Stoke Newington.
G1906 Jan. 20 TA1908 Apr. 25 TAM1911 July 29	*DARBY, H., A.M. Inst. C.E.	Town Hall, Ealing, W.
G1901 June 8 TAM1911 July 29	*DAVIDGE, W. R., Assoc. M. Inst. C.E.	District Surveyor, Lewisham. Bank House, 95 High Street, Lewisham.
G1913 Mar. 15 TAM1913 Sept. 6	DAVIES, A. G. A.	Engineering Assistant to Borough Engineer, Worthing.
G1902 July 10 TAM1911 July 29	*DAWKINS, F.	Borough Surveyor's Office, Bournemouth.
1913 Feb. 8	*DEAN, F. W.	Engineering Assistant, Town Hall, Withington, Manchester.
1913 Jan. 4	DEAN, S.	Assistant Engineer, Urban District Council, Barnoldswick.
G1903 Dec. 12 TA1905 May 27 TAM1911 July 29	*DEBNEY, W., A.M. Inst. C.E.	Borough Engineer's Office, Birkenhead.
G1907 Nov. 2 TAM1911 July 29	*DE COLLEVILLE, H. M.	48 Bedford Row, W.C.
G1902 July 10 TAM1911 July 29	*DEELEY, G. P.	Moushall, Amblecote, Brierley Hill, Staffs.
A1904 Aug. 19 TAM1911 July 29	DE KRETSER, H. K.	The Star Fort, Matara, Ceylon.
1912 Mar. 2	*DEWHURST, J. T.	Assistant Engineer to Urban District Council, Audenshaw.
A1904 Aug. 12 TAM1911 July 29	DONALD, R. B., A.M.Inst.C.E.	Chief Engineering Assistant, Borough Engineer's Office, Huddersfield.
1912 July 11	*DUCKWORTH, W. Hy.	Council Offices, Watford, Herts.
1913 June 21	*DUNBAR, W.	Engineering Assistant to Burgh Engineer, Dunoon.

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Date of Election and Transfer.		
G1910 June 16 TAM1911 July 29	*Durkin, F., A.M.Inst.C.E. ..	Engineering Assistant, Borough Surveyor's Office, West Hartlepool.
1912 Oct. 26	*Dyke, G.	Engineer's Office, Town Hall, Walsall.
G1906 May 26 TAM1911 July 29	*Eayrs, T. W., A.M.Inst.C.E.	City Engineer's Office, Council House, Birmingham.
1913 May 24	Edwards, E. F.	Engineering Assistant, Borough Engineer's Office, Southend-on-Sea.
A1909 Dec. 11 TAM1911 July 29	*Elliott, A. H.	Engineering Assistant to City Engineer, Nottingham.
1913 May 24	*Fairclough, R. L.	Assistant Surveyor to the Urban District Council, Blyth.
G1886 Sept. 11 TAM1911 July 29	*Fenton, W. C.	10 Paradise Square, Sheffield.
G1900 June 16 TAM1911 July 29	*Fisher, R.	10 Fairlight Avenue, Harlesden, N.W.
G1910 Mar. 12 TAM1911 July 29	*Fletcher, R., A.M. Inst. C.E.	Assistant County Surveyor, Worcestershire County Council. "Stonall," West Road, Bromsgrove.
1912 Dec. 7	*Folland, G. R.	Chief Assistant to County Surveyor, No. 1 Division, Devon. The Square, Barnstaple.
G1903 July 25 TAM1911 July 29	*Ford, J.	Lower House, Branscombe, Beer, S.O.
G1899 Oct. 21 TA1903 July 25 TAM1911 July 29	*Foster, H. H.	66 Boundaries Road, Balham, S.W.
A1910 Jan. 22 TAM1911 July 29	*Foster, H. P.	Chief Assistant, P.W. Engineer's Office, City Tramways, Leeds.
1913 Feb. 8	*Fryer, G. E.	Chief Assistant Surveyor, Urban District Council, Ripley.
G1907 Dec. 14 TA1910 Jan. 22 TAM1911 July 29	*Furness, D.	City Surveyor's Office, Town Hall, Manchester.
A1909 Oct. 30 TAM1911 July 29	Gardner, J., A.M. Inst. C.E.	123 Boothferry Road, Goole.
G1899 June 10 TAM1911 July 29	*Gibson, W. S.	D'Arcy House, Hendon Lane, Finchley, N.
G1888 July 12 TAM1911 July 29	*Glass, S. N., A.M. Inst. C.E.	4 Western Gardens, Ealing Common, W.
G1906 Dec. 15 TA1908 Dec. 5 TAM1911 July 29	*Goldsmith, W. H.	Engineering Assistant, Town Hall, Hull.
G1908 Dec. 5 TAM1911 July 29	*Goodacre, E. J., A.M. Inst. C.E.	Municipal Offices, Nuneaton.

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Date of Election and Transfer.		
A1905 June 22 TAM1911 July 29	*GOODE, W. J.	Divisional Surveyor, Shropshire. Wellington, Salop.
G1899 Dec. 16 TA1902 May 10 TAM1911 July 29	*GOODFELLOW, H., A.M.Inst. C.E.	Chief Engineering Assistant, Town Hall, Southport.
A1903 July 25 TAM1911 July 29	GRAY, A. R.	Engineering Assistant, Council House, Birmingham.
1913 June 21	*GREENWOOD, C.	Engineering Assistant to Borough Engineer, St. Helens, Lancs.
G1906 May 26 TA1908 June 25 TAM1911 July 29	*GRIFFITHS, H.	Borough Surveyor's Office, Crewe.
G1904 Dec. 3 TAM1911 July 29	*GROVE, A.	1 Parkfield Terrace, Stourbridge.
G1905 June 22 TAM1911 July 29	*GUNSON, E., A.M. Inst. C.E.	27 Galloway Avenue, Buffalo, New York, U.S.A.
1913 Feb. 8	HAKE, R. J.	Engineering Assistant, Rural District Council, Williton, Somerset.
1912 Sept. 9	*HAMMOND, B. C.	County Road Surveyor's Department, Shire Hall, Worcester.
1913 Jan. 4	HANCOCK, C. C.	Engineer and Surveyor, Rural District Council, Warminster.
1913 June 21	HARBOTTLE, W. G.	Engineering Assistant to City Surveyor, Manchester.
A1903 June 6 TAM1911 July 29	HARDING, H. W.	Chief Engineering Assistant, City Engineer's Office, Bristol.
G1904 Jan. 23 TAM1911 July 29	*HARKNESS, J.	2 Barnes Terrace, Ayr.
G1908 May 23 TAM1911 July 29	*HARMER, E. F.	25 Mansion Road, Southampton.
G1905 Oct. 28 TAM1911 July 29	*HASSALL, J.	Department of Highways and Sewers, Town Hall, Sheffield.
G1907 Mar. 2 TAM1911 July 29	*HAZELTINE, C. A., A.M.Inst. C.E.	Borough Engineer's Office, Stepney.
A1903 June 6 TAM1911 July 29	HEAP, H., A. M. Inst. C.E. ..	16 Manor Avenue, Grimsby.
A1904 Aug. 26 TAM1911 July 29	HENDERSON, R. T...	City Engineer's Office, City Chambers, Glasgow.
1913 Apr. 19	HIGGINS, T.	Engineering Assistant, Town Hall, Leicester.
1913 Jan. 4	*HILL, J. R.	Surveying Assistant, Borough Surveyor's Office, Rochdale.
S1912 Sept. 9 TAM1913 June 21	*HILL, J. W.	Engineering and Surveying Assistant to Borough Surveyor, Stoke-on-Trent.
G1907 Mar. 2 TA1908 Apr. 25 TAM1911 July 29	*HODGE, A. C...	City Surveyor's Office, Sheffield.

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Date of Election and Transfer.		
A1911 June 10 TAM1911 July 29	*HOLDEN, L.	Engineering Assistant to the Llandaff and Dinas Powis Rural District Council. 24 St. David's Avenue, Cardiff
G1906 Mar. 3 TAM1911 July 29	*HOLDEN, R. B.	Town Hall, Oldham.
1912 July 11	*HOPLEY, S. F.	Assistant Surveyor, Bedwellty Urban District Council, Glam.
1913 June 21	HOSSACK, W. B.	Assistant Road Surveyor to third division Middle Ward of Lanarkshire. Deveron Bank, Airdrie.
1913 June 21	HOWARTH, J...	Engineering Assistant to the Heywood and Middleton Water Board. Water Offices, Heywood, Lancs.
G1904 Oct. 29 TAM1911 July 29	*HOWELL, H. H., A.M.Inst.C.E.	City Engineering Assistant, 63 Queen Square, Bristol.
G1909 Jan. 23 TAM1911 July 29	*HUGHES, W. H.	Assistant Surveyor, Urban District Council, Maesteg, Glam.
1911 Dec. 2	*HUNT, J. C.	City Engineer's Office, 63 Queen Square, Bristol.
1912 Jan. 13	HUNTER, L. McL...	Assistant Engineer, City Engineer's Office, Ottawa, Canada.
A1910 Jan. 22 TAM1911 July 29	*HURCOMB, H. F.	"Elmhurst," Baring Road, Beaconsfield.
G1899 June 10 TAM1911 July 29	*HUTCHINGS, W. A...	Springfield Brewery, Wolverhampton.
G1909 Dec. 11 TAM1911 July 29	*HUTSON, E. G., A.M. Inst. C.E.	c/o Messrs. Diggle and Son, Water Offices. Hind Hill Street, Heywood, Lancs.
A1909 June 5 TAM1911 July 29	*HYBART, F. R.	Engineer's Office, Urban District Council, Barry.
1913 May 24	INGHAM, J. W.	Engineering Assistant, Public Offices, Enfield, Middlesex.
1913 Apr. 19	JAKEWAY, A. W.	Engineering Assistant, Town Hall, Hereford.
1913 Feb. 8	JAMES, J. T.	Main Road Inspector, Shire Hall, Hereford.
A1909 Dec. 11 TAM1911 July 29	*JARMAN, G. E.	c/o Valvoline Oil Company, Bombay, India.
G1905 Jan. 28 TAM1911 July 29	*JENNINGS, W...	Borough Engineer's Office, Leyton.
G1907 May 25 TA1908 Sept. 5 TAM1911 July 29	*JOHNSON, W. H.	City Surveyor's Office, Town Hall, Chester.

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Date of Election and Transfer.		
1912 Jan. 13	*Jones, D. L.	Engineering Assistant, Borough Engineer's Office, Merthyr.
G1908 Dec. 5 TAM1911 July 29	*Jones, J. A.	Assistant Surveyor, Director of Works Dept., Admiralty. 72 Grafton Road, East Acton, W.
1913 Feb. 8	*Jones, R. O.	Engineering Assistant, County Hall, Cardiff.
G1906 Dec. 15 TAM1911 July 22	*Jones, Thomas	7 Grove Road, Wallasey.
A1909 July 17 TAM1911 July 29	*Keay, E. N.	Borough Surveyor's Office, Eastbourne.
A1910 Dec. 10 TAM1911 July 29	Kent, C. G., A.M.Inst.C.E.	16 Bamford Road, Didsbury, Manchester.
1913 Mar. 15	Kidd, C. C.	Engineering Assistant, Borough Engineer's Office, Southend-on-Sea.
A1910 June 16 TAM1911 July 29	*Kindell, F. P.	Engineering Assistant, Council Offices, Beckenham.
1912 July 11	*Kirby, S. J.	District Surveyor, P. W. D., Mannar, Ceylon.
G1903 June 25 TA1909 Feb. 27 TAM1911 July 29	*Knight, R. R.	City Engineer, Corporation Offices, Fort William, Ontario, Canada.
G1903 June 25 TAM1911 July 29	*Knowles, G. P., B.Sc. (Eng.) Lond., A.M. Inst. C.E.	39 Victoria Street, S.W.
1913 June 21	*Lavender, W. A...	Engineering Assistant to the Rural District Council, Blean. Surveyor's Office, Eddington, Herne Bay.
1913 Jan. 4	Lawson, H. M.	Deputy Road Surveyor, Council House, Birmingham.
A1909 Feb. 27 TAM1911 July 29	Leeper, L., B.Eng., A.M. Inst.C.E.	Assistant Engineer, Town Hall, Great Yarmouth.
A1911 Jan. 21 TAM1911 July 29	*Leney, C. W...	Highway Surveyor, Rural District Council, East Preston, West Sussex.
G1911 June 10 TAM1911 July 29	*Letheren, W. H.	Borough Engineer's Office, Northampton.
1913 June 21	*Lewis, F. J. D.	Engineering and Surveying Assistant to the Urban District Council, Acton, W.
G1904 June 25 TA1910 Jan. 22 TAM1911 July 29	*Lewis, H. M...	"The Pollards," Langborough, Wokingham, Berks.
G1904 Dec. 3 TAM1911 July 29	*Line, H. W.	L.C.C., 19 Charing Cross Road, S.W.
G1907 May 25 TAM1911 July 29	*Loach, A. E...	City Surveyor's Office, Wakefield.

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Date of Election and Transfer.		
1911 Dec. 2	*LOCKWOOD, G. O.	County Surveyor's Office, The Castle, Winchester.
A1909 Dec. 11 TAM1911 July 29	*LONGSTAFF, J. T.	Engineer's Department, P.W.D., Hong Kong. 18 Bank Buildings, Hong Kong.
G1905 May 27 TAM1911 July 29	*MCARD, A. J.	Borough Engineer's Office, Whitehaven.
G1900 Dec. 15 TAM1911 July 29	*MACDONALD, K. G.	13 Charles Street, St. James's, S.W.
1912 Apr. 27	*MCGLASHAN, J. S.	Town Hall, Wallasey.
A1904 Sept. 6 TAM1911 July 29	MCINNES, D.	City Engineer's Office, Glasgow.
1912 Feb. 10	*MACMILLAN, R. S...	Burgh Surveyor's Office, Clydebank.
G1903 June 25 TAM1911 July 29	*MANN, E. E., B.Sc., A.M. Inst.C.E.	Borough Engineer's Office, Southampton.
1913 Apr. 19	MANN, F. W...	Engineering Assistant, Town Hall, Leicester.
A1904 Aug. 4 TAM1911 July 29	MARR, G. E.	District Offices, Hamilton.
1913 July 16	MASON, J. W.	Engineering Assistant to the Urban District Council, Walthamstow.
G1903 Jan. 17 TAM1911 July 29	*MASTERS, W. H.	Glencairn, Arthur Road, Southampton.
G1905 Jan. 28 TA1907 June 20 TAM1911 July 29	*MATHEW, H. B., A.M.Inst. C.E.	City Engineer's Office, Birmingham.
G1906 Dec. 15 TA1909 Mar. 27 TAM1911 July 29	*MATTHEWS, R. H., A.M. Inst. C.E.	Chief Engineering Assistant, Urban District Council, Wood Green.
G1900 June 16 TAM1911 July 29	*MATTINSON, H., A.M.Inst.C.E.	55 Piccadilly, Manchester.
1913 Jan. 4	MAXWELL, J...	Engineering Assistant, County Road Surveyor's Office, Hamilton.
A1909 Sept. 4 TAM1911 July 29	*MESSENT, E. J., A.M. Inst. C.E.	Resident Engineer, New Sewerage Works, Prittlewell, Southend.
1913 June 21	*METCALFE, W.	Engineering Assistant to County Surveyor, Yorks West Riding. Kellingley, Knottingley, Yorks.
G1901 Oct. 19 TAM1911 July 29	*MILNES, B.	Borough Engineer's Office, Birkenhead.
A1908 Oct. 24 TAM1911 July 29	MITCHELL, J. G.	City Engineer's Office, Edinburgh.
G1898 Dec. 17 TA1901 Oct. 19 TAM1911 July 29	*MITCHELL, G.	Water Engineer's Office, Aberdeen.
1913 June 21	*MORGAN, D. R.	Engineering and Surveying Assistant, City Hall, Cardiff.
G1905 June 22 TAM1911 July 29	*MORGAN, G. L.	Lan Wood, Pontypridd.

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Date of Election and Transfer.	Name	Address
1913 Feb. 8	Morris, P.	Town Planning Assistant, Surveyor's Office, Rural District Council, Doncaster.
A1904 Sept. 19 TAM1911 July 29	Morrison, A. W.	City Engineer's Office, Edinburgh.
A1911 Mar. 4 TAM1911 July 29	*Moser, W.	294 Scotland Road, Nelson, Lancs.
G1902 Jan. 25 TAM1911 July 29	*Moss, W.	14 Hesketh Avenue, Didsbury, Manchester.
1913 June 21	*Mozley, F. W.	Chief Engineering Assistant to Borough Engineer, Nelson.
G1906 Jan. 20 TA1910 June 16 TAM1911 July 29	*Murray-Smith, A., A.M.Inst. C.E.	Municipal Offices, Cheltenham.
1910 Mar. 2	*Nelson, B. A.	Surveying Assistant, Borough Surveyor's Office, Southport.
G1909 July 17 TAM1911 July 29	*Newcomen, T. G.	Assistant Surveyor, Council Offices, Portsmouth Road, Thames Ditton, Surrey.
A1910 Jan. 22 TAM1911 July 29	*Newman, J. A.	Engineering Assistant, Birmingham Water Department.
G1906 Jan. 20 TAM1911 July 29	*Newsome, S. H.	"Bunswick," Totley Brook Road, Jotley Rise, near Sheffield.
G1904 May 28 TAM1911 July 29	*Nicholls, R., A.M. Inst. C.E.	Borough Engineer's Office, Southampton.
G1896 June 25 TAM1911 July 29	*Nightingale, C. F.	"Endellion," Buchanan Road, Walsall.
G1905 Sept. 23 TAM1911 July 29	*Nighy, J.	Council Offices, Dartford.
1912 Apr. 27	*Norman, J. W.	Assistant Superintendent of Public Works, British North Borneo. Jesselton, British North Borneo.
G1910 Mar. 12 TAM1911 July 29	*Oddy, J. R. R.	Engineering Assistant to County Surveyor, West Riding. Bradford, Yorks.
G1907 June 20 TAM1911 July 29	*Ollevant, H. E.	Church Street, Greasboro', near Rotherham.
G1895 June 27 TA1902 July 10 TAM1911 July 29	*Openshaw, J., A.M.Inst.C.E.	Engineering Assistant, Town Hall, Salford.
1912 June 1	*Osborne, H. J.	Council Offices, Rudolph Road, Bushey, Herts.
PG1905 Jan. 28 TAM1911 July 29	*Owen, J., A.M.Inst.C.E.	Assistant City Engineer, Fort William, Ontario, Canada.

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Date of Election and Transfer.		
G1899 Oct. 21 TAM1911 July 29	*Palmer, G. F.	c/o Messrs. Norton Griffiths and Co., St. Johns, New Brunswick, Canada.
1912 Dec. 7	Palmer, T	Engineering Assistant, City Engineer's Office, Lincoln.
1912 Mar. 2 R1913 Sept. 6	*Panton, A. W., M.A., B.A.I., A.M.Inst.C.E.	100 Bothwell Street, Glasgow.
G1906 Dec. 15 TAM1911 July 29	*Parker, E.	Stretford District Council Offices, Old Trafford, Manchester.
1912 Feb. 10	*Payne, P. I., A.M.Inst.C.E.	1 Stanley Villas, Artillery Road, Guildford.
1913 Jan. 4	Peach, L. W.	Engineering Assistant, Urban District Council, Cannock, Staffs.
G1906 Dec. 15 TAM1911 July 29	*Peacock, J. L.	Sewage Works Contract, Newtownards, Co. Down.
G1906 June 28 TAM1911 July 29	*Pearce, W. H., A.M. Inst. C.E.	Town Hall, Swanage.
G1904 June 25 TAM1911 July 29	*Pearson, T. G.	Town Hall, Barrow-in-Furness.
G1895 Jan. 19 TA1901 Oct. 19 TAM1911 July 29	*Perkins, J.	Engineering Assistant, Council House, Birmingham.
G1896 Feb. 22 TAM1911 July 29	*Perkins, T. L., A.M. Inst.C.E.	P. W. D., Hong Kong.
G1903 Feb. 21 TAM1911 July 29	*Perrott, E. S.	District Engineer, City Engineer's Office, Bristol.
G1902 July 10 TAM1911 July 29	*Phillips, R.	Southgate District Council Offices, Palmer's Green, N.
G1901 Aug. 24 TAM1911 July 29	*Pickin, W. H.	Engineer's Department, L.C.C., Spring Gardens, S.W.
1913 Jan. 4	*Pilling, E.	Engineering Assistant, Urban District Council, Lytham.
A1909 Sept. 4 TAM1911 July 29	*Pollard, H. E.	Engineering Assistant, Shanghai Municipality.
G1906 Dec. 15 TAM1911 July 29 R1912 Jan. 13	*Pool, H...	Borough Surveyor's Office, Stoke-on-Trent.
PG1909 Feb. 27 TAM1911 July 29	*Price, A. J.	Borough Surveyor's Office, Eccles.
1913 Feb. 8	Pritchard, E.	Engineering Assistant, London County Council, County Hall, Spring Gardens, S.W.
1913 Feb. 8	Pritty, F.	Engineering Assistant, City Chambers, Glasgow.
1912 Feb. 10	Pryde, J.	Assistant County Road Surveyor, Queen Anne Street, Dunfermline.
G1898 June 30 TAM1911 July 29	*Quick, A. H., Assoc. M. Inst. C.E.	"Inverness," Malvern Road, Thornton Heath.

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Date of Election and Transfer.	Name	Address
1913 June 21	RACKHAM, H. W.	Engineering Assistant to the Rural District Council, Hendon. Great Stanmore.
1913 June 21	RADCLIFFE, E. H.	Engineering Assistant to Borough Engineer, Rotherham.
G1900 Dec. 15 TAM1911 July 29	*RAWSTRON, C. O.	Surveyor's Office, Rural District Council, Lichfield, Staffs.
1912 Jan. 13	REAN, W. H.	88 Oxford Gardens, W.
G1902 Nov. 8 TAM1911 July 29	*REDFORD, W. T.	City Surveyor's Office, Town Hall Manchester.
1913 Feb. 8	REECE, P. A.	Engineering Assistant, Town Hall, Manchester. 53 Heald Place, Rusholme, Manchester.
A1910 June 16 TAM1911 July 29	REED, F.	Assistant Engineer, L.C.C. Trams, 51 Hotham Road, Putney.
A1904 Aug. 31 TAM1911 July 29	REID, M...	Burgh Engineer's Office, Paisley.
1913 July 16	*RICHARDS, C. V.	Surveying Assistant to City Surveyor, Manchester.
A1911 June 10 TAM1911 July 29	*RICHARDSON, T. C., A.M. Inst. C.E.	N69 Rua de Santa Luzia, Rio de Janiero, S. America.
G1904 May 28 TA1908 Sept. 5 TAM1911 July 29	*RICHMOND, W. S., A.M.Inst. C.E.	Engineering Assistant, Town Hall, Hornsey.
1913 Apr. 19	*RIGBY, G.	Engineering Assistant, P.W.D Belgaum, India.
1912 Mar. 2	RIMELL, H. C.	Senior Engineering Assistant, Corporation Water Works, Cardiff.
G1908 July 18 TAM1911 July 29	*ROBERTS, L. G.	27 Salford Road, Telford Park, Streatham Hill, S.W.
1913 June 21	ROEBUCK, J. H.	Chief Engineering Assistant to the Eton Rural District Council. Slough.
G1900 Feb. 10 TAM1911 July 29	*ROSS, D.	"Balnagowan," Charleston Road, Eastbourne.
1911 Dec. 2	*ROTHWELL, J. T.	Town Hall, Barrow-in-Furness.
1911 Sept. 23	*RUBIE, W. C.	Council House, Birmingham.
A1910 May 24 TAM1911 July 29	*SANDERSON, H., A.M.Inst.C.E.	Borough Engineer's Office, Keighley.
G1904 May 28 TAM1911 July 29	*SCHLUND, W. T. S.	14 Vernham Road, Plumstead Common, S.E.
1913 Feb. 8	SCHOLFIELD, E. F.	Chief Engineering Assistant, Rural District Council, Burnley.
1912 July 11	*SCOTT, A. D.	Borough Engineer's Office, Barrow-in-Furness.
A1910 Jan. 22 TAM1911 July 29	*SENIOR, S. M...	Engineering Assistant, City Engineer's Office, York.

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Date of Election and Transfer.		
1912 Dec. 7	SHAW, D. H.	Chief Engineering Assistant, County Buildings, Dunfermline, Fife.
A1911 Mar. 4 TAM1911 July 29	*SHELLARD, I. F.	Borough Surveyor's Office, Newport, Mon.
G1909 Dec. 11 TAM1911 July 29	*SIDDONS, B. L.	"Carson Hall," Kent Street, Sydney, N.S.W.
G1899 June 29 TAM1911 July 29	*SIMMS, F.	City Engineer's Department, Town Hall, Sheffield.
G1910 June 16 TAM1911 July 29	*SKILLMAN, J.	Engineering Assistant, Council Offices, Hounslow, Middlesex.
1913 July 16	*SLATER, W.	Engineering Assistant to the Urban District Council, Leek.
1913 Mar. 15	*SMALL, S. S.	Assistant Engineer, Urban District Council, Leigh-on-Sea.
1911 Sept. 23	SMITH, P. H. A.	Town Hall, Leicester.
G1906 May 26 TAM1911 July 29	*SMITH, W. B.	Borough Surveyor's Office, Town Hall, Paddington, W.
1913 Feb. 8	*SMITH, W. J...	Engineering Assistant, Urban District Council, Willesden. Public Offices, Dyne Road, Kilburn, N.W.
1913 Feb. 8	SMYTH, J. H...	Engineering Assistant, Urban District Council, Willesden. Public Offices, Dyne Road, Kilburn, N.W.
G1908 Dec. 5 TAM1911 July 29	*STALEY, F. G.	The Road Board, Queen Anne's Chambers, Westminster, S.W.
G1907 June 20 TAM1911 July 29	*STANYER, F.	Fullford House, Lichfield.
A1911 July 5 TAM1911 July 29	*STATHAM, A. P.	Town Hall, Salford.
A1904 Aug. 22 TAM1911 July 29	STEPHEN, T. M.	District Offices, Hamilton.
A1904 Apr. 30 TAM1911 July 29	STORY, G. E.	14 Park Road North, Bedford.
1913 Sept. 6	STUBBS, P. E.	Engineering Assistant to the Urban District Council, Hendon.
G1911 June 10 TAM1911 July 29	*STURGESS, G.	"Clovelly," 15 Bowerdean St., Fulham, S.W.
A1911 June 10 TAM1911 July 29	*STUTTLE, B. W.	Borough Engineer's Office, Stepney.
G1906 Mar. 3 TAM1911 July 29	* SUTCLIFFE, H.	25 Rosehill Road, Burnley.
1912 Feb. 10	*SWINDELLS, H. C.	Engineering Assistant, District Surveyor's Office, Withington, Manchester.

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Date of Election and Transfer.		
1912 Jan. 13	TAYLOR, A. S. V., A.M.Inst. C.E.	Surveyor to the Urban District Council, Bedwas and Machen.
G1900 Dec. 15 TAM1911 July 29	*TAYLOR, H. T.	3 North Terrace, Gt. Meols, Hoylake, Cheshire.
A1910 Mar. 12 TAM1911 July 29	*TAYLOR, R.	Engineering Assistant to Borough Surveyor, Haslingden.
A1908 Oct. 24 TAM1911 July 29	*TEASDALE, G. W.	9 Persehouse Street, Walsall, Staffs.
G1907 Sept. 7 TAM1911 July 29	*THOMAS, E.	Works Department, Admiralty, Whitehall, S.W.
A1910 Apr. 23 TAM1911 July 29	THOMAS, W. N.	26 Robin Hood Chase, Nottingham.
G1911 June 10 TAM1911 July 29 B1912 Jan. 13	*THOMPSON, W. H.	City Engineer's Department, Council House, Birmingham.
1911 Dec. 2	THOMSON, J. B.	Public Offices, Southall, Middlesex.
1913 Apr. 19	THORPE, H. S.	Engineering Assistant, Guildhall, York.
G1907 Sept. 7 TA1908 Sept. 5 TAM1911 July 29 B1912 Jan. 13	*TOMEY, N. G.	City Engineer's Department, Council House, Birmingham.
G1905 Sept. 23 TAM1911 July 29	*TONGE, J. A.	Engineer and Surveyor, Urban District Council, Rawmarsh. Parkgate, Rotherham.
G1909 July 17 TAM1911 July 29	*TONKS, H. J.	Heath Villa, Willenhall.
1913 Jan. 4	TRACY, B. D...	Engineering Assistant, City Engineer's Office, Guildhall, E.C.
G1908 Sept. 5 TAM1911 July 29	*TRODD, J. W...	Engineer's Department, Town Hall, Leyton, E.
G1904 May 28 TAM1911 July 29	*TULLEY, G. W.	3 Parliament Square, Edinburgh.
1912 Apr. 27	TURNER, E. W.	City Engineer's Office, Town Hall, Sheffield.
G1910 Jan. 22 TAM1911 July 29	*TURNER, S. G.	81 The Vineyard, Richmond, Surrey.
1912 Feb. 10	*VANSTONE, C. D. H.	Assistant Surveyor, Town Hall, Teignmouth, Devon.
G1905 May 27 TAM1911 July 29	*VERNON, A.	Town Hall, Upper Street, Islington.
1913 Apr. 19	*WAINWRIGHT, H. C.	Engineering Assistant, Glamorganshire County Council. County Hall, Cardiff.
A1909 June 5 TAM1911 July 29	*WAIT, O. H.	Engineer's Office, P.W.D., Penang, S.S.
1913 Feb. 8	*WALSH, W.	Engineering Assistant, Borough Engineer's Office, Blackburn.

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Date of Election and Transfer.		
G1888 Jan. 14 TAM1911 July 29	*WARD, F. D., A. M. Inst. C.E.	42 Field Road, New Brighton.
G1897 June 19 TA1908 Oct. 24 TAM1911 July 29	*WEBB, F.	Assistant to Borough Surveyor, Chelsea.
G1911 July 5 TAM1911 July 29	*WEBB, O. S.	Engineering Assistant, Public Offices. Teddington.
G1898 Jan. 15 TAM1911 July 29	*WELLS, F. B., Assoc. M. Inst. C.E.	c/o The Great Southern Railway Co., Buenos Aires.
G1902 Sept. 6 TAM1911 July 29	*WEST, A. S., A.M.Inst.C.E...	Water Engineer, Waterworks Offices, 7 Haywra Crescent, Harrogate.
G1902 July 10 TA1905 Jan. 28 TAM1911 July 29	*WHITAKER, G. H., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Sunderland.
1913 July 16	*WHITAKER, G.	Engineering Assistant to the Fylde Water Board, Blackpool.
G1901 June 8 TAM1911 July 29	*WHITEFORD, E. H., M. Inst. C.E.	Resident Engineer, Derwent Reservoir Works, Derwent, via Sheffield.
G1902 Nov. 8 TA1904 Feb. 27 TAM1911 July 29	*WIBBERLEY, J., A.M.Inst.C.E.	Engineering Assistant, Municipal Offices, Plymouth.
1912 Dec. 7	*WICKENDEN, E.	City Surveyor's Office, Town Hall, Manchester.
G1901 Aug. 24 TA1907 Nov. 2 TAM1911 July 29	*WILKINSON, H. F., A.M.Inst. C.E.	Senior Engineering Assistant, Urban District Council, Tottenham.
G1901 June 27 TAM1911 July 29	*WILLETT, A. J.	18 Castledine Road, Anerley, S.E.
G1895 June 27 TAM1911 July 29	*WILLIAMS, D. S.	2 Lan Park Road, Pontypridd, Glam.
1900 Dec. 15 R1913 Feb. 8	*WILLS, A. J.	106 Kenmore Buildings, Winnipeg, Manitoba, Canada.
G1910 May 24 TAM1911 July 29	*WINTLE, A.	33 Strawberry Hill Road, Twickenham.
A1910 Mar. 12 TAM1911 July 29	WISHLADE, T. W., A. M. Inst. C.E.	Borough Surveyor's Office, Town Hall, Bermondsey, S.E.
A1908 Sept. 5 TAM1911 July 29	WOOD, H., A.M.Inst.C.E. ..	Chief Sewerage Assistant, City Engineer's Office, Norwich.
1913 Apr. 19	WOOD, T.	Engineering Assistant, Town Hall, Leicester.
G1900 July 19 TAM1911 July 29	*WRACK, W. P.	117 High Street, Poplar, E.
S1912 Dec. 7 TAM1913 June 21	*WREST, J.	Engineering Assistant to Borough Engineer, Dewsbury.
G1904 June 25 TAM1911 July 29	*WRIGHT, F. W.	Resident Engineer's Office, Heanor Road, Ilkeston, Derbyshire.
G1906 May 26 TAM1911 July 29	*WRIGHT, W., A.M.Inst.C.E...	Assistant Surveyor, Municipal Offices, Sutton, Surrey.

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TOPOGRAPHICAL LIST
OF
MEMBERS AND ASSOCIATE MEMBERS.

A.	*signifies*	Abroad.	S.	*signifies*	Southern District.
Af.	„	African District.	S.W.	„	South-Western Dist.
E.	„	Eastern District.	Ind.	„	Indian District.
N.E.	„	North-Eastern District.	I.	„	Irish District.
N.W.	„	North-Western District.	Met.	„	Metropolitan District.
W.M.	„	West Midland District.	Scot.	„	Scottish District.
E.M.	„	East Midland District.	W.N.	„	Welsh District (North).
S.E.	„	South-Eastern District.	W.S.	„	„ „ (South).

TOWN.	DISTRICT.		NAME.
Aberdeen	Scot.	M	W. Dyack.
Aberdeen	Scot.	M	J. Gordon.
Aberdeen	Scot.	AM	G. Mitchell.
Aberdeenshire (County)	Scot.	M	G. Calvert.
Aberdeenshire (County)	Scot.	M	A. H. Clayton.
Abergavenny	W.S.	M	F. Mansfield.
Abersychan	W.S.	M	E. Whitwell.
Abingdon	S.	M	G. Winship.
Accrington	N.W.	M	W. J. Newton.
Accrington	N.W.	M	F. H. Holden.
Accrington	N.W.	M	H. Hamer.
Acton	E.	M	F. Sadler.
Acton	E.	AM	J. A. Jones.
Acton	E.	AM	F. J. D. Lewis.
Acton	E.	AM	H. B. Crossley.
Aethwy (Rural)	W.N.	M	J. Kershaw.
Airdrie	Scot.	M	H. Inglis.
Alberta, Canada	A.	AM	G. B. Underhill.
Aldershot	S.	M	F. C. Uren.
Alexandria	A.	M	D. E. Lloyd-Davies.
Alsager	N.W.	M	H. V. Lynam.
Alton	S.	M	G. B. Hartfree.
Alton (Rural)	S.	M	C. W. Maudsley.
Altrincham	N.W.	M	H. E. Brown.
Ambleside	N.W.	M	C. Watson.
Andover	S.	M	R. W. Knapp.
Anerley	S.E.	AM	A. J. Willett.
Annfield Plain	N.E.	M	T. J. Trowsdale.
Antrim (County)	I.	M	J. H. Brett.
Anuradapura, Ceylon	Ind.	M	A. H. Nathanielsz.
Arbroath	Scot.	M	P. C. Smith.
Argyllshire (County)	Scot.	M	M. B. McBeth.
Armagh (County)	I.	M	R. H. Dorman.
Armagh	I.	M	J. C. Boyle.
Arnold	E.M.	AM	R. E. Clarke.
Ascot	S.	M	A. M. Fowler.

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TOWN.	DISTRICT.		NAME.
Ashborne	E.M.	M	J. Abbott.
Ashby-de-la-Zouch (Rural)	E.M.	M	S. Turner.
Ashfield, New South Wales	A.	M	J. D. Goodwin.
Ashford	S.E.	M	W. Terrill.
Ashford (Rural)	S.E.	M	A. Sims.
Ashton-on-Mersey	N.W.	M	F. Hutton.
Ashton-under-Lyne	N.W.	M	J. T. Earnshaw.
Ashton-under-Lyne	N.W.	M	F. J. Dixon.
Ashton-under-Lyne	N.W.	M	J. Rowbottom.
Atherstone (Rural)	W.M.	M	H. J. Coleby.
Auckland, New Zealand	A.	M	W. E. Bush.
Audenshaw	N.W.	M	W. Clough.
Audenshaw	N.W.	AM	J. T. Dewhurst.
Axminster (Rural)	S.W.	M	G. A. Millard.
Aylesbury	E.	M	W. H. Taylor.
Aylesbury (Rural)	E.	M	R. T. Stewart.
Ayr	Scot.	M	J. Young.
Ayrshire (County)	Scot.	M	A. Stevenson.
Ayrshire (County)	Scot.	AM	W. Bonn.
Bacup	N.W.	M	W. H. Elce.
Bacup	N.W.	M	J. Wilson.
Balby with Hexthorpe	N.E.	M	G. Gledhill.
Balham	Met.	AM	H. H. Foster.
Ballymena	I.	M	H. O'Hara.
Banbury	S.	M	G. E. Wrigley.
Barking	E.	M	C. F. Dawson.
Barking	E.	M	C. J. Dawson.
Barmouth	W.N.	M	T. R. Parry.
Barnes	S.E.	M	G. B. Tomes.
Barnes	S.E.	AM	J. R. Cartledge.
Barnoldswick	N.E.	AM	S. Dean.
Barnstaple	S.W.	M	E. Y. Saunders.
Barrow-in-Furness	N.W.	M	A. Race.
Barrow-in-Furness	N.W.	M	W. C. Persey.
Barrow-in-Furness	N.W.	AM	J. A. Charles.
Barrow-in-Furness	N.W.	AM	T. G. Pearson.
Barrow-in-Furness	N.W.	AM	J. T. Rothwell.
Barrow-in-Furness	N.W.	AM	A. D. Scott.
Barry	W.S.	M	J. C. Pardoe.
Barry	W.S.	M	E. R. Hinchsliff.
Barry	W.S.	AM	F. R. Hybart.
Barton-on-Irwell (Rural)	N.W.	M	A. H. Mountain.
Basford (Rural)	E.M.	M	S. Maylan.
Basford (Rural) (Highways)	E.M.	M	G. W. Hawley.
Basingstoke	S.	M	F. R. Phipps.
Bath	S.W.	AM	A. Coles.
Batley	N.E.	M	H. L. Hall.
Battersea	Met.	M	T. W. A. Hayward.
Battersea	Met.	M	W. J. Dresden.

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TOWN.	DISTRICT.		NAME.
Battersea	Met.	M	H. A. White.
Baynes Lake, British Columbia	A.	AM	W. J. E. Biker.
Beaconsfield	E.	AM	H. F. Hurcomb.
Beccles	E.	M	C. L. Hamby.
Beckenham	S.E.	M	J. A. Angell.
Beckenham	S.E.	M	H. S. Best.
Beckenham	S.E.	AM	F. P. Kindell.
Bedford (County)	E.	M	W. H. Leete.
Bedford (County)	E.	M	F. W. S[illegible]art.
Bedford (County)	E.	M	H. L. Harrison.
Bedford (County)	E.	M	R. J. Taylor.
Bedford	E.	M	N. Greenshields.
Bedford	E.	AM	J. H. Castle.
Bedford	E.	AM	G. E. Story.
Bedwas and Machen	W.S.	AM	A. S. V. Taylor.
Bedwellty	W.S.	M	D. H Price.
Bedwellty	W.S.	AM	S. F. Hopley.
Beer	S.W.	AM	J. Ford.
Belfast	I.	M	H. A. Cutler.
Belfast	I.	M	H. F. Gullan.
Belgaum	Ind.	AM	G. Rigby.
Belper	E.M.	M	T. Fenn.
Belper (Rural)	E.M.	M	R. C. Cordon.
Benoni, Transvaal	Af.	M	D. P. Howells.
Benwell and Fenham	N.E.	M	W. P. Pattison.
Berkhamsted (Rural)	E.	M	H. N. Hedges.
Berkshire (County)	S.	M	J. F. Hawkins.
Bermondsey	Met.	M	R. J. Angel.
Bermondsey	Met.	AM	T. W. Wishlade.
Bermondsey	Met.	AM	S. H. Andrews.
Berwick East (County)	Scot.	M	J. Wilson.
Berwick-on-Tweed	N.E.	M	R. Dickinson.
Bethnal Green	Met.	M	A. E. Darby.
Beverley	N.E.	M	J. G. Smith.
Beverley (Rural)	N.E.	M	E. Picker.
Bexhill	S.E.	M	G. Ball.
Bexhill	S.E.	AM	J. R. Fothergill.
Bexley	S.E.	M	W. T. Howse.
Biddulph	W.M.	M	S. Gibson.
Biggleswade	E.	M	T. Cockrill.
Biggleswade (Rural)	E.	M	J. O. Jones.
Billericay (Rural)	E.	M	R. J. W. Layland.
Bingley	N.E.	M	H. Bottomley.
Birkdale	N.W.	M	J. Mitchell.
Birkdale	N.W.	M	W. Nuttall.
Birkenhead	N.W.	M	C. Brownridge.
Birkenhead	N.W.	M	R. W. Johnston.
Birkenhead	N.W.	AM	W. Debney.
Birkenhead	N.W.	AM	B. Milnes.
Birmingham	W.M.	M	H. E. Stilgoe.
Birmingham (Sewers and Rivers)	W.M.	M	E. B. Savage.
Birmingham	W.M.	M	J. D. Watson.

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TOWN.	DISTRICT.		NAME.
Birmingham	W.M.	M	J. E. Willcox.
Birmingham	W.M.	M	H. Richardson.
Birmingham	W.M.	M	J. E. Parr.
Birmingham	W.M.	M	A. S. Parsons.
Birmingham	W.M.	M	W. E. Ballard.
Birmingham	W.M.	M	C. E. Lawton.
Birmingham	W.M.	M	J. S. King.
Birmingham	W.M.	AM	W. H. Thompson.
Birmingham	W.M.	AM	N. G. Tomey.
Birmingham	W.M.	AM	E. E. W. Butt.
Birmingham	W.M.	AM	T. W. Eayrs.
Birmingham	W.M.	AM	A. R. Gray.
Birmingham	W.M.	AM	H. B. Mathew.
Birmingham	W.M.	AM	J. A. Newman.
Birmingham	W.M.	AM	J. Perkins.
Birmingham	W.M.	AM	W. C. Rubie.
Birmingham	W.M.	AM	H. M. Lawson.
Birstall	N.E.	M	T. H. Hailstone.
Bishop's Stortford	E.	M	R. S. Scott.
Bispham with Norbreck	N.W.	M	T. Harrop.
Blackburn	N.W.	M	W. Stubbs.
Blackburn	N.W.	M	W. A. Foster.
Blackburn	N.W.	M	J. T. Shield.
Blackburn	N.W.	AM	L. D. Brothers.
Blackburn	N.W.	AM	W. Walsh.
Blackpool	N.W.	M	J. S. Brodie.
Blackpool (Water)	N.W.	M	J Cook.
Blackpool (Water)	N.W.	AM	G. Whitaker.
Blackwell (Rural)	E.M.	M	H. Silcock.
Blaenavon	W.S.	M	E. W. Edwards.
Blandford	S.W.	M	P. C. Woodhall.
Blean (Rural)	S.E.	AM	W. A. Lavender.
Blyth	N.E	M	R. Grieves.
Blyth	N.E.	AM	R. L. Fairclough.
Blyth and Cuckney (Rural)	E.M.	M	F. Hopkinson.
Bognor	S.E.	M	O. A. Bridges.
Bolton	N.W.	M	E. L. Morgan.
Bolton	N.W.	AM	W. Bentley.
Bombay	Ind.	M	J. Hall.
Bombay (Water)	Ind.	M	H. J. T. Smith.
Bombay	Ind.	AM	G. E. Jarman.
Bo'ness	Scot.	M	J. Louden.
Bootle	N.W.	M	B. J. Wolfenden.
Boston	E.M.	M	G. E. Clarke.
Bourne (Rural) (Highways)	E.M.	M	T. Lake.
Bournemouth	S.	M	F. W. Lacey.
Bournemouth	S.	M	F. P. Dolamore.
Bournemouth	S.	M	W. H. Mackenzie.
Bournemouth	S.	AM	F. Dawkins.
Bradford	N.E.	M	J. H. Cox.
Bradford	N.E.	M	R. Armistead.
Bradford	N.E.	M	J. W. Foster.

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TOWN.	DISTRICT.		NAME.
Bradford-on-Avon	S.	M	R. B. Lees.
Brecon	W.S.	M	H. Ll. Griffiths.
Breconshire (County)	W.S.	M	W. L. Harpur.
Brentford	E.	M	J. W. Croxford.
Brentford	E.	M	N. Parr.
Brentwood	E.	M	A. J. Meeson.
Bridgwater	S.W.	M	F. Parr.
Bridgwater (Rural)	S.W.	M	W. A. Collins.
Bridlington	N.E.	M	E. R. Matthews.
Bridlington (Rural)	N.E.	M	S. Dyer.
Brierfield	N.W.	M	B. Halstead.
Brierley Hill	W.M.	M	J. L. Harpur.
Brierley Hill	W.M.	AM	G. P. Deeley.
Brighouse	N.E.	M	S. S. Haywood.
Brighouse	N.E.	M	H. L. Bottomley.
Brighton	S.E.	M	H. Tillstone.
Brighton (Water)	S.E.	M	J. Johnston.
Brisbane	A.	M	T. Kirk.
Brisbane	A.	M	W. E. Irving.
Bristol	S.	M	T. H. Yabbicom.
Bristol	S.	M	W. H. G. Kieser.
Bristol	S.	M	E. W. Lashmore.
Bristol	S.	M	F. Wilson.
Bristol	S.	M	A. J. Saise.
Bristol	S.	M	J. A. Wright.
Bristol	S.	M	A. H. Claypoole.
Bristol	S.	M	L. S. McKenzie.
Bristol	S.	M	W. L. F. Palmer.
Bristol	S.	AM	H. W. Harding.
Bristol	S.	AM	H. H. Howell.
Bristol	S.	AM	E. S. Perrott.
Bristol	S.	AM	J. C. Hunt.
Bristol	S.	AM	A. Clibbens.
British North Borneo	A.	AM	J. W. Norman.
British Uganda	Af.	M	J. D. Milner.
Briton Ferry	W.S.	M	H. Alex. Clarke.
Brixton	Met.	M	J. P. Norrington.
Broadstairs	S.E.	M	H. Hurd.
Bromyard	W.M.	M	J. D. Barrs.
Broughty Ferry	Scot.	M	T. K. Roddan.
Brownhills	W.M.	M	J. H. Shaw.
Brynmawr	W.S.	M	J. J. Quirk.
Buckfastleigh	S.W.	M	W. J. Goode.
Buckhaven	Scot.	M	P. Sinclair.
Buckhurst Hill	E.	M	H. Tooley.
Buckingham (County)	E.	M	R. J. Thomas.
Buckingham	E.	AM	H. J. Chapman.
Buenos Aires	A.	AM	J. G. Bryans.
Buenos Aires	A.	AM	F. B. Wells.
Buenos Aires	A.	AM	L. G. Duncan.
Buffalo, New York	A.	AM	E. Gunson.
Bulawayo, Rhodesia	Af.	M	J. Younger.

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TOWN.	DISTRICT.		NAME.
BURNHAM	S.W.	M	W. H. Chowins.
BURNLEY	N.W.	M	G. H. Pickles.
BURNLEY	N.W.	M	J. P. Greenwood.
BURNLEY	N.W.	M	J. T. Landless.
BURNLEY (Rural)	N.W.	M	H. Pritchard.
BURNLEY	N.W.	AM	J. W. E. Brown.
BURNLEY	N.W.	AM	H. Sutcliffe.
BURNLEY	N.W.	AM	E. F. Scholfield.
BURNTISLAND	Scot.	M	J. A. Waddell.
BURSLEM	W.M.	M	F. Bettany.
BURSLEM	W.M.	M	F. P. Sissons.
BURTON-ON-TRENT	W.M.	M	G. T. Lynam.
BURTON-ON-TRENT	W.M.	M	W. Thompson.
BURY	N.W.	M	T. Yelland.
BURY	N.W.	M	J. Cartwright.
BURY	N.W.	M	J. A. Settle.
BUSHEY	E.	M	E. E. Ryder.
BUSHEY	E.	AM	H. J. Osborne.
BUXTON	E.M.	M	F. Langley.
CAERPHILLY	W.S.	M	A. O. Harpur.
CAIRO (P.W.D.)	Af.	M	C. C. James.
CAIRO	Af.	M	S. F. L. Fox.
CAIRO	Af.	M	S. S. Dawson.
CAIRO	Af.	M	W. H. McLean.
CAITHNESS (County)	Scot.	M	W. Kirkland.
CALCUTTA	Ind.	M	J. Maden.
CALCUTTA	Ind.	AM	N. N. Bose.
CALCUTTA	Ind.	M	E. P. Richards.
CALCUTTA	Ind.	AM	K. C. Bannerjee.
CALLANDER	Scot.	M	W. Nicol.
CAMBERWELL	Met.	M	F. J. Slater.
CAMBORNE	S.W.	M	C. D. Bell.
CAMBRIDGE (County)	E.	M	J. E. Blackwall.
CAMBRIDGE	E.	M	J. Julian.
CANNOCK	W.M.	M	R. Blanchard.
CANNOCK	W.M.	AM	B. W. Peach.
CANTERBURY	S.E.	M	A. C. Turley.
CAPE TOWN	Af.	M	T. W. Cairncross.
CAPE TOWN	Af.	M	A. E. Snape.
CARDIFF	W.S.	M	W. Harpur.
CARDIFF (Water)	W.S.	M	C. H. Priestley.
CARDIFF	W.S.	M	W. H. Haigh.
CARDIFF	W.S.	M	F. W. Greenhill.
CARDIFF	W.S.	AM	D. R. Morgan.
CARDIFF (Water)	W.S.	AM	H. C. Rimmell.
CARLISLE	N.W.	M	H. C. Marks.
CARLISLE	N.W.	M	W. W. R. Harlow.
CARLTON	E.M.	M	J. C. Haller.
CARNARVON	W.N.	M	E. Hall.

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TOWN.	DISTRICT.		NAME.
Carnarvonshire (County)	W.N.	M	E. Evans.
Carnoustie	Scot.	M	D. Maxwell.
Castleford	N.E.	M	W. Green.
Chadderton	N.W.	M	L. M. Hindle.
Chapel-en-le-Frith	N.W.	M	H. T. Hughes.
Chard (Rural)	S.W.	M	R. Stephens.
Chatham	S.E.	M	C. Day.
Chatham	S.E.	M	R. L. Honey.
Cheadle	W.M.	M	T. Bibbey.
Chelmsford	E.	M	P. T. Harrison.
Chelmsford	E.	M	S. Matthew.
Chelmsford (Rural)	E.	M	J. Dewhirst.
Chelsea	Met.	M	T. W. E. Higgens.
Chelsea	Met.	M	W. R. Manning.
Chelsea	Met.	AM	F. Webb.
Cheltenham	S.	M	J. S. Pickering.
Cheltenham	S.	M	W. H. J. White.
Cheltenham	S.	AM	A. Murray-Smith.
Cheriton	S.E.	M	A. O. Sherren.
Chesham	E.	M	P. C. Dormer.
Cheshire (County)	N.W.	M	H. F. Bull.
Cheshunt	E.	M	J. E. Sharpe.
Chester	N.W.	M	W. H. M. Jones.
Chester	N.W.	M	I. M. Jones.
Chester	N.W.	AM	W. H. Johnson.
Chesterfield	E.M.	M	V. Smith.
Chesterton	E.	M	J. D. Bland.
Chesterton (Rural)	E.	M	J. Dunn.
Chippenham	S.	M	A. E. Adams.
Chippenham (Rural)	S.	M	A. H. Lapham.
Chiswick	E.	M	E. Willis.
Chiswick	E.	AM	L. A. Cooper.
Chittagong, Eastern Bengal	Ind.	M	A. F. Henderson.
Chorley	N.W.	M	W. Leigh.
Christchurch	S.	M	H. J. Farmer.
Church	N.W.	M	W. E. Wood.
Claypole (Rural)	E.M.	M	P. A. Watford.
Clayton-le-Moors	N.W.	M	A. Dodgeon.
Cleckheaton	N.E.	M	C. Lund.
Cleckheaton	N.E.	AM	E. J. P. Bedford.
Cleethorpes	E.M.	M	E. Rushton.
Cleethorpes	E.M.	M	C. H. Waithman.
Clent	W.M.	AM	C. E. Cox.
Clydebank	Scot.	M	G. Ross.
Clydebank	Scot.	AM	R. S. MacMillan.
Coalville	E.M.	M	L. L. Baldwin.
Coatbridge	Scot.	M	C. Young.
Cockermouth (Rural)	N.W.	M	J. B. Wilson.
Cockfosters	E.	M	W. H. Savage.
Colchester	E.	M	H. Goodyear.
Colchester	E.	M	E. A. Slater.
Colne	N.W.	M	T. H. Hartley.

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TOWN.	DISTRICT.		NAME.
Colombo, Ceylon	Ind.	M	F. A. Cooper.
Colombo, Ceylon	Ind.	M	R. Skelton.
Colombo, Ceylon	Ind.	M	C. L. Cox.
Colombo, Ceylon	Ind.	M	H. B. Lees.
Colombo, Ceylon	Ind.	M	C. H. Kilmister
Colombo, Ceylon	Ind.	M	P. W. Harrison.
Colwyn Bay	W.N.	M	W. Jones.
Colwyn Bay	W.N.	M	W. J. Dunning.
Congleton	N.W.	M	R. Burslam.
Congleton	N.W.	M	J. R. Walters.
Conway (Rural)	W.N.	M	T. B. Farrington.
Cork, West (County)	I.	M	R. W. F. Longfield.
Cork	I.	M	J. F. Delany.
Cornwall (County)	S.W.	M	A. E. Brookes.
Cornwall Central (County)	S.W.	M	W. J. Merrett.
Cornwall (County)	S.W.	M	G. Palmer.
Cosford (Rural)	E.	AM	C. D. Bright.
Cowes	S.	M	J. W. Webster.
Cranbrook (Rural)	S.E.	M	E. R. Lewis.
Crewe	N.W.	M	G. Eaton-Shore.
Crewe	N.W.	M	W. J. Ball.
Crewe	N.W.	AM	H. Griffiths.
Crieff	Scot.	M	A. W. Allison.
Cromer	E.	M	R. Croome.
Croydon	S.E.	M	G. F. Carter.
Croydon (Highways)	S.E.	M	E. F. Morgan.
Croydon (Rural)	S.E.	M	R. M. Chart.
Croydon (Rural)	S.E.	M	R. Chart.
Croydon	S.E.	AM	A. Bromly.
Croydon (Rural)	S.E.	AM	A. Clark.
Cumberland	N.W.	M	W. Finch.
Cupar (County)	Scot.	M	T. Aitken.
Darlington	N.E.	M	R. E. Cole.
Darlington	N.E.	M	E. Minors.
Dartford	S.E.	M	T. E. Tiffen.
Dartford	S.E.	AM	J. Nighy.
Dartmouth (Water)	S.W.	M	W. G. Lane.
Darwen	N.W.	M	R. W. Smith-Saville.
Daventry	E.	M	J. B. Williams.
Dawlish (Water)	S.W.	M	S. F. C. Churchward.
Deal	S.E.	M	T. C. Golder.
Delhi	Ind.	M	T. Salkield.
Denny	Scot.	AM	T. M. Brown.
Deptford	Met.	M	J. Sutcliffe.
Derby (County)	E.M.	M	J. W. Horton.
Derby (County)	E.M.	M	A. J. Metcalfe.
Derby	E.M.	M	J. Ward.
Derby	E.M.	M	C. A. Clews.
Derby	E.M.	AM	E. H. Bennett.
Derwent	N.E.	AM	E. H. Whiteford.

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TOWN.	DISTRICT.		NAME.
Devon (County)	S.W.	M	S. Ingram.
Devon (County)	S.W.	M	W. P. Robinson.
Devon (County)	S.W.	AM	G. R. Folland.
Dewsbury	N.E.	M	H. Dearden.
Dewsbury	N.E.	AM	J. Wrest.
Dewsbury	N.E.	AM	G. Atkinson.
Didsbury	N.W.	AM	W. Moss.
Didsbury	N.W.	AM	C. G. Kent.
Doncaster	N.E.	M	F. O. Kirby.
Doncaster (Rural)	N.E.	M	W. R. Crabtree.
Doncaster (Rural)	N.E.	AM	P. Morris.
Dore (Rural)	W.M.	M	F. Britton
Dorchester	S.W.	M	H. D. Strange.
Dorking	S.E.	M	W. A. Clegg.
Dorking (Rural)	S.E.	M	W. Rapley.
Dorset (County)	S.W.	M	W. T. Fletcher.
Dorset (County)	S.W.	M	G. R. Marsh.
Douglas, Isle of Man	N.W.	M	F. Cottle.
Douglas, Isle of Man (Highways)	N.W.	M	W. R. Kay.
Douglas, Isle of Man	N.W.	M	A. D. Barron.
Dover	S.E.	M	W. C. Hawke.
Down (County)	I.	M	J. Heron.
Driffield (Rural)	N.E.	M	T. C. Beaumont.
Droylsden	N.W.	M	C. Hall.
Dublin (County)	I.	M	W. Collen.
Dublin	I.	M	M. J. Buckley.
Dudley	W.M.	M	J. Gammage.
Dukinfield	N.W.	M	S. Hague.
Dumbarton (County)	Scot.	M	J. Andrew.
Dumbartonshire (County)	Scot.	M	A. Wilson.
Dumfries	Scot.	M	A. M. Hart.
Dumfries	Scot.	M	J. Barker.
Dundalk	I.	M	M. Sellars.
Dundalk & Ardee (Rural)	I.	M	P. Cahill.
Dundee	Scot.	M	J. Thomson.
Dundee	Scot.	M	J. B. Paterson.
Dunedin, New Zealand	A.	M	W. D. R. McCurdie.
Dunfermline (County)	Scot.	M	D. MacKenzie.
Dunfermline	Scot.	M	J. E. Wilkes.
Dunfermline	Scot.	AM	J. Pryde.
Dunmow (Rural Highways)	E.	M	R. W. Burton.
Dunoon	Scot.	AM	W. Dunbar.
Dunstable	E.	M	J. Stewart.
Durham (Rural)	N.E.	M	G. Gregson.
Ealing	E.	M	W. R. Hicks.
Ealing	E.	M	W. C. Sillitoe.
Ealing	E.	AM	H. Darby.
Ealing	E.	AM	S. N. Glass.
East Barnet Valley	E.	M	H. York.
East Barnet Valley	E.	M	E. J. Willis.

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TOWN.	DISTRICT.		NAME.
East Dereham	E.	M	F. L. Burch.
East Ham	E.	M	J. Birch.
East Ham	E.	M	A. T. Bridgewater.
East Ham	E.	M	H. L. Baker.
East London, Cape Colony	Af.	M	J. Powell.
East Malling (Rural)	S.E.	M	J. Marshall.
East Molesey	S.E.	M	J. Stevenson.
East Preston (Rural)	S.E.	AM	C. W. Leney.
East Retford	E.M.	M	J. D. Kennedy.
East Retford (Rural)	E.M.	M	T. Henry.
East Stow (Rural)	E.	M	G. F. P. Harrison
Eastbourne	S.E.	M	A. E. Prescott.
Eastbourne	S.E.	M	J. R. Thackeray.
Eastbourne	S.E.	AM	E. N. Keay.
Eastbourne	S.E.	AM	D. Ross.
Easthampstead (Rural)	S.	M	J. R. Treadwell.
Eastleigh & Bishopstoke	S.	M	W. W. Gandy.
Eastwood	E.M.	M	A. G. Wheeler.
Ebbw Vale	W.S.	M	T. J. Thomas
Eccles	N.W.	M	T. S. Picton.
Eccles	N.W.	AM	A. J. Price.
Edinburgh	Scot.	M	A. H. Campbell.
Edinburgh (Highway)	Scot.	M	A. K. Christie.
Edinburgh	Scot.	M	A. S. Robertson.
Edinburgh	Scot.	M	W. H. Wainwright.
Edinburgh	Scot.	M	J. Walker Smith.
Edinburgh	Scot.	M	W. Forbes.
Edinburgh	Scot.	M	J. Storrar.
Edinburgh	Scot.	AM	J. Harkness.
Edinburgh	Scot.	AM	J. G. Mitchell.
Edinburgh	Scot.	AM	A. W. Morrison.
Edinburgh	Scot.	AM	G. W. Tulley.
Edmonton	E.	M	C. Brown.
Edmonton	E.	M	A. B. Lismer.
Elgin	Scot.	M	A. A. Turriff.
Eltham Green	Met.	M	R. Findlay.
Enfield	E.	M	R. Collins.
Enfield	E.	M	J. T. Briscoe.
Enfield	E.	AM	W. R. Collins.
Enfield	E.	AM	J. W. Ingham.
Enniskillen (County)	I.	M	J. P. Burkitt.
Epsom	S.E.	M	E. R. Capon.
Epsom	S.E.	M	H. B. Longley.
Erdington	W.M.	M	H. H. Humphries.
Essex (County)	E.	M	A. J. Lyddon.
Eston	N.E.	M	C. McDermid.
Eton (Rural)	E.	M	R. Hallam.
Eton (Rural)	E.	M	A. Gladwell.
Eton (Rural)	E.	AM	J. H. Roebuck.
Eton	E.	M	G. Smith.
Evesham	W.M.	M	H. S. Harvey.
Evesham & Pebworth (Rural)	W.M.	M	E. Holloway.

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TOWN.	DISTRICT.		NAME.
Exeter	S.W.	M	T. Moulding.
Exmouth	S.W.	M	S. Hutton.
Exmouth	S.W.	M	J. C. Matthew.
Failsworth	N.W.	M	W. McN. Shimmin.
Falkirk	Scot.	M	D. Ronald.
Falkirk	Scot.	M	C. Massie.
Falmouth	S.W.	M	J. S. Walton.
Fareham	S.	M	W. Butler.
Farnborough	S.	M	J. E. Hargreaves.
Farnham	S.E.	M	R. W. Cass.
Faversham	S.E.	M	S. P. Andrews.
Featherstone	N.E.	M	S. Chesney.
Felixstowe	E.	M	H. Clegg.
Fenny Stratford	E.	M	J. Chadwick.
Fermoy and Mallow	I.	M	D. J. Buckley.
Fife (County) (Highways)	Scot.	M	A. Forbes.
Fife (County)	Scot.	AM	D. H. Shaw.
Finchampstead	S.	M	Lt.-Col. A. S. Jones.
Finchley	E.	M	C. J. Jenkin.
Finchley	E.	M	J. H. Catchpole.
Finchley	E.	AM	E. M. Bull.
Finchley	E.	AM	W. S. Gibson.
Finsbury	Met.	M	P. G. Killick.
Fleet	S.	M	H. J. Chivers.
Flintshire (County)	W.N.	M	S. Evans.
Foleshill (Rural)	W.M.	M	A. E. Newey.
Folkestone	S.E.	M	A. E. Nichols.
Folkestone	S.E.	M	H O. Jones.
Foots Cray	S.E.	M	W. A. Farnham.
Fort William, Ont.	A.	M	R. R. Knight.
Fort William, Ont.	A.	AM	J. Owen.
Fremantle, W. Australia	A.	M	H. T. Haynes.
Friern Barnet	E.	M	E. J. Reynolds.
Frimley	S.E.	M	T. C. Jones.
Frinton-on-Sea	E.	M	E. M. Bate.
Frome	S.W.	M	F. W. Jones.
Frome (Rural)	S.W.	M	J. A. Beynon.
Fulham	Met.	M	H. D. Austin.
Fulham	Met.	AM	G. Sturgess.
Fulwood	N.W.	M	A. E. Coupe.
Gainsborough	E.M.	M	S. W. Parker.
Gateshead	N.E.	M	N. P. Pattinson.
Gellygaer	W S.	M	F. Read.
Gillingham	S.E.	M	J. L. Redfern.
Glamorganshire (County)	W.S.	M	G. A. Phillips.
Glamorganshire (County)	W.S.	M	E. C. Pole.

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TOWN.	DISTRICT.		NAME.
Glamorganshire (County)	W.S.	AM	R. O. Jones.
Glamorganshire (County)	W.S.	AM	H. C. Wainwright.
Glasgow	Scot.	M	T. Nisbet.
Glasgow	Scot.	M	W. C. Easton.
Glasgow	Scot.	M	J. Bryce.
Glasgow (Water)	Scot.	M	J. R. Sutherland.
Glasgow (Water)	Scot.	AM	J. Cochrane.
Glasgow	Scot.	AM	R. T. Henderson.
Glasgow	Scot.	AM	D. McInnes.
Glasgow (Water)	Scot.	AM	J. A. Booth.
Glasgow (Water)	Scot.	AM	R. A. Campbell.
Glasgow	Scot.	AM	F. Pritty.
Glasgow	Scot.	AM	A. W. Panton.
Glastonbury	S.W.	M	G. Alves.
Gloucester (County)	S.	M	E. S. Sinnott.
Gloucester	S.	M	R. Read.
Gloucester	S.	M	E. W. A. Carter.
Gloucester	S.	M	R. Phillips.
Glyncorrwg	W.S.	M	W. P. Jones.
Godalming	S.E.	M	J. H. Norris.
Gold Coast	Af.	M	D. S. Palk.
Goole	N.E.	M	C. G. Bradley.
Goole	N.E.	AM	J. Gardner.
Gorton	N.W.	M	C. J. Lomax.
Gosforth	N.E.	M	G. Nelson.
Gosport	S.	M	W. H. Fry.
Gosport and Alverstoke	S.	M	H. Frost.
Gosport and Alverstoke	S.	M	F. C. Harvey.
Govan	Scot.	M	F. G. Holmes.
Grangemouth	Scot.	M	D. A. Donald.
Grantham	E.M.	M	W. Wright.
Gravesend	S.E.	M	F. T. Grant.
Gravesend	S.E.	M	R. Saunders.
Grays Thurrock	E.	M	A. C. James.
Greasboro'	N.E.	AM	H. E. Ollevant.
Great Yarmouth	E.	M	J. W. Cockrill.
Great Yarmouth	E.	AM	L. Leeper.
Great Yarmouth	E.	AM	O. H. Cockrill.
Greenock	Scot.	M	W. D. Low.
Greenwich	Met.	M	C. P. Smith.
Grey County, New Zealand	A.	M	J. Higgins.
Grimsby	E.M.	M	H. G. Whyatt.
Grimsby	E.M.	M	J. G. R. Baxter.
Grimsby	E.M.	AM	H. Heap.
Guernsey	S.	M	T. J. Guilbert.
Guildford	S.E.	M	C. G. Mason.
Guildford (Rural)	S.E.	M	J. Anstee.
Guildford	S.E.	AM	P. I. Payne.
Guildford, West Australia	A.	M	G. S. L. Bains.
Gundurimba	A.	M	T. O. Cudbird.

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TOWN.	DISTRICT.		NAME.
Hackney	Met.	M	N. Scorgie.
Hadham and Stansted (Rural)	E.	M	E. T. Watts.
Halesowen (Rural)	W.M.	M	G. H. Dallow.
Halifax (Rural)	N.E.	M	F. Gordon.
Halifax	N.E.	M	A. C. Tipple.
Ham	S.E.	M	R. W. Hindhaugh.
Hamilton	Scot.	M	W. H. Purdie.
Hamilton	Scot.	AM	J. Maxwell.
Hamilton, New Zealand	A.	M	S. B. Sims.
Hammersmith	Met.	M	H. Mair.
Hammersmith	Met.	AM	E. W. Ludford.
Hampshire (County)	S.	M	W. J. Taylor.
Hampshire (County)	S.	AM	G. O. Lockwood.
Hampstead	Met.	M	O. E. Winter.
Hampstead	Met.	M	J. Williams.
Hampton	E.	M	S. H. Chambers.
Hampton Wick	E.	M	P. Taylor.
Hanwell	E.	M	S. W. J. Barnes.
Harlesden	E.	AM	R. Fisher.
Harpenden	E.	M	H. Leverton.
Harrogate	N.E.	M	C. E. Rivers.
Harrogate (Water)	N.E.	AM	A. S. West.
Harrow	E.	M	J. P. Bennetts.
Harrow	E.	M	T. Charles.
Hartshorne and Seals (Rural)	E.M.	M	N. F. Spence.
Haslemere	S.E.	M	H. V. Snook.
Haslingden	N.W.	M	J. S. Green.
Haslingden	N.W.	AM	R. Taylor.
Hastings	S.E.	M	P. H. Palmer.
Hastings	S.E.	M	G. F. Miller.
Hastings, New South Wales	A.	M	M. R. Smith.
Hatch End	E.	M	C. A. Woodbridge.
Havant (Rural)	S.	M	W. L. Hibberd.
Hawick, N.B.	Scot.	M	Chas. Brown.
Hay	W.M.	AM	A. E. Smith.
Heavitree	S.W.	M	F. E. Simpson.
Hebden Bridge	N.E.	M	T. Waddingham.
Heckmondwike	N.E.	M	J. Saville.
Hemel Hempstead	E.	M	W. R. Locke.
Hemel Hempstead (Rural)	E.	M	T. H. Lighbody.
Hendon (Rural)	E.	M	W. Gornall.
Hendon (Rural)	E.	M	J. A. Webb.
Hendon (Rural)	E.	AM	H. W. Rackham.
Hendon	E.	AM	P. E. Stubbs.
Hereford (County)	W.M.	M	G. H. Jack.
Hereford	W.M.	M	J. Parker.
Hereford	W.M.	AM	A. W. Jakeway.
Hereford (Rural)	W.M.	M	R. Curtis Cordon.
Herne Bay	S.E.	M	F. W. J. Palmer.
Hertford	E.	M	J. H. Jevons.
Hertfordshire	E.	M	T. Bowes.
Hertfordshire (Highways)	E.	M	E. Parry.

TOWN.	DISTRICT.		NAME.
Heston and Isleworth	E.	M	J. G. Carey.
Hertfordshire	E.	M	C. Vawser.
Hertfordshire	E.	M	E. W. Pullen.
Hertfordshire	E.	M	W. Gregory.
Hertfordshire	E.	AM	L. M. Bennett.
Hertfordshire	E.	AM	J. T. James.
Hexham	N.E.	M	G. L. Murray.
Heysham	N.W.	M	H. Miller.
Heywood	N.W.	M	J. B. Nuttall.
Heywood	N.W.	AM	E. G. Hutson.
Heywood (Water)	N.W.	M	J. Diggle.
Heywood (Water)	N.W.	M	J. S. Diggle.
Heywood (Water)	N.W.	AM	J. Howarth.
High Wycombe	E.	M	T. J. Rushbrook.
High Wycombe	E.	M	A. L. Grant.
Hinckle	E.M.	M	E. H. Crump.
Hindley	N.W.	M	O. P. Abbott.
Hipperholme	N.E.	M	G. W. Thompson.
Hitchin	E.	M	A. T. Blood.
Hobson, New Zealand (County)	A.	M	H. Hammond.
Holborn	Met.	M	E. F. Spurrell.
Holborn	Met.	M	O. Cattlin.
Holborn	Met.	M	A. Greenwell.
Holsworthy (Rural)	S.W.	M	F. J. Harris.
Holyhead	W.N.	M	A. Asquith.
Hong Kong	A.	M	H. E. Goldsmith.
Hong Kong	A.	M	A. F. Churchill.
Hong Kong	A.	AM	J. T. Longstaff.
Hong Kong	A.	AM	T. L. Perkins.
Hong Kong	A.	M	D. J. Brown.
Honiton (Rural)	S.W.	M	W. North.
Horncastle	E.M.	M	F. Weeber.
Hornsea	N.E.	M	W. E. Warburton.
Horbury	N.E.	M	W. Sugars.
Hornsey	E.	M	E. J. Lovegrove.
Hornsey	E.	M	A. C. Collis-Adamson.
Hornsey	E.	AM	W. S. Richmond.
Hounslow	E.	M	S. F. R. Carter.
Hounslow	E.	AM	J. Skillman.
Hove	S.E.	M	H. H. Scott.
Hove	S.E.	AM	M. B. Bennett.
Howrah, Bengal	Ind.	M	A. Hale.
Hoylake	N.W.	M	W. H. Maitland.
Hoylake	N.W.	M	R. W. Fraser.
Hoylake	N.W.	AM	H. T. Taylor.
Hoyland Nether	N.E.	M	F. J. Thackray.
Huddersfield	N.E.	M	K. F. Campbell.
Huddersfield (Gas)	N.E.	M	E. A. Harman.
Huddersfield	N.E.	M	H. Sutcliffe.
Huddersfield	N.E.	AM	R. B. Donald.
Huelva, Spain	A.	M	W. T. Curry.
Hull	N.E.	M	A. E. White.

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TOWN.	DISTRICT.		NAME.
Hull	N.E.	M	P. Gaskell.
Hull	N.E.	AM	W. H. Goldsmith.
Hungerford (Rural) (Highways)	S.	M	W. S. Raine.
Hunslet (Rural)	N.E.	M	J. Nuttall.
Huntingdon (County)	E.	M	H. J. G. Leete.
Huntingdon (County)	E.	AM	J. E. Cardell.
Hythe	S.E.	M	Chris. Jones.
Ilford	E.	M	H. Shaw.
Ilford	E.	M	G. G. Shepherd.
Ilfracombe	S.W.	M	O. M. Prouse.
Ilkeston	E.M.	AM	F. W. Wright.
Inverness	Scot.	M	T. H. Scott.
Inverness (County) (Highways)	Scot.	M	R. Robertson.
Inverness	Scot.	M	D. MacBean.
Ipswich	E.	M	E. Buckham.
Ipswich	E.	M	J. R. Mead.
Irlam	N.W.	M	R. H. Winterbottom.
Isle of Ely, North (County)	E.	M	H. F. Simpson.
Isle of Ely, South (County)	E.	M	R. S. W. Perkins.
Isle of Thanet (Rural)	S.E.	M	G. L. Butterworth.
Isle of Wight (Rural)	S.	M	H. B. Cullin.
Isle of Wight (Rural) (Highways)	S.	M	L. A. Cozens.
Islington	Met.	M	J. P. Barber.
Islington	Met.	M	J. E. Cooke.
Islington	Met.	AM	P. A. Moss.
Islington	Met.	AM	A. Vernon.
Jarrow	N.E.	M	J. S. Weir.
Johannesburg	Af.	M	C. Aburrow.
Johannesburg	Af.	M	W. Ingham.
Johnstone	Scot.	M	W. A. MacCartney.
Jotley Rise	N.E.	AM	S. H. Newsome.
Karachi	Ind.	M	M. Lea.
Kedah, Malay States	A.	M	J. Gorman.
Kedah, Malay States	A.	AM	R.W.St.G.Caulfeild.
Keighley	N.E.	M	W. Fowlds.
Keighley	N.E.	AM	H. Sanderson.
Kendal	N.W.	M	F. W. Oxberry.
Kenilworth	W.M.	M	S. Douglas.
Kensington	Met.	M	A. R. Finch.
Kensington	Met.	AM	H. Rean.
Kent (County)	S.E.	M	F. R. Ruck.
Kent (County)	S.E.	M	F. W. Greig.

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TOWN.	DISTRICT.		NAME.
Keswick	N.W.	M	W. Hodgson.
Kettering	E.	M	T. R. Smith.
Keynsham (Rural)	S.W.	M	H. M. Bennett.
Keynsham (Rural)	S.W.	M	H. A. Endsor.
Kidderminster (Rural)	W.M.	M	G. J. Shepherd.
Kilkenny (County)	I.	M	A. M. Burden.
King's Lynn	E.	M	A. J. Smith.
King Williamstown	Af.	M	T. G. Caink.
Kilmarnock	Scot.	M	R. Blackwood.
Kingsbury	E.	M	R. C. N. Newport.
Kingston, Jamaica	A.	M	C. V. Abrahams.
Kingston-on-Thames	S.E.	M	R. H. Clucas.
Kintyre	Scot.	M	J. S. Smith.
Kirkcaldy	Scot.	M	J. L. Lumsden.
Kirkcudbright	Scot.	M	J. D. Smith.
Kirklam	N.W.	M	T. H. Maxwell.
Kirriemuir, N.B.	Scot.	M	J. S. Bruce.
Kiveton Park (Rural)	N.E.	M	F. Hewitt.
Klipfontein	Af.	M	A. C. V. Baines.
Knaresborough	N.E.	M	R. E. Wilson.
Krugersdorp, Transvaal	Af.	M	R. A. Webster.
Lagos	Af.	M	W. Wright.
Lahore	Ind.	M	W. G. Longdin.
Lambeth	Met.	M	H. C. J. Edwards.
Lambeth	Met.	M	H. E. Anderson.
Lanark (County)	Scot.	M	W. L. Douglass.
Lanark (County)	Scot.	M	W. A. Chapman.
Lanark (County)	Scot.	M	R. Spittal.
Lanark (County)	Scot.	M	J. Watson.
Lanark (County)	Scot.	AM	G. E. Marr.
Lanark (County)	Scot.	AM	T. M. Stephen.
Lanark (County)	Scot.	AM	W. B. Hossack.
Lancashire (County)	N.W.	M	W. H. Schofield.
Lancaster	N.W.	M	F. Hill.
Lancaster (Water)	N.W.	M	A. G. Bradshaw.
Langport (Rural)	S.W.	M	J. Mathison.
Lathom and Burscough	N.W.	M	T. Burrows.
Leatherhead	S.E.	M	S. R. Drake.
Ledbury	W.M.	M	R. G. Gurney.
Leeds	N.E.	M	W. T. Lancashire.
Leeds (Sewerage)	N.E.	M	G. A. Hart.
Leeds	N.E.	M	R. B. Holt.
Leeds	N.E.	M	W. Dixon.
Leeds	N.E.	M	J. W. Witts.
Leeds	N.E.	AM	H. P. Foster.
Leek	W.M.	M	W. E. Beacham.
Leek	W.M.	M	A. M. Kinnison.
Leek	W.M.	AM	W. Slater.
Leicester (County)	E.M.	M	S. P. Pick.

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TOWN.	DISTRICT.		NAME.
Leicester	E.M.	M	E. G. Mawbey.
Leicester	E.M.	M	W. H. A. Court.
Leicester	E.M.	AM	P. H. A. Smith.
Leicester	E.M.	AM	T. Higgins.
Leicester	E.M.	AM	F. S. Coburn.
Leicester	E.M.	AM	T. Wood.
Leicester	E.M.	AM	F. W. Mann.
Leicestershire	E.M.	M	C. T. Garratt.
Leigh	N.W.	M	T. Hunter.
Leigh	N.W.	M	T. A. Clare.
Leigh	N.W.	AM	F. L. Boydell.
Leigh-on-Sea	E.	M	J. W. Liversedge.
Leigh-on-Sea	E.	AM	S. S. Small.
Leiston	E.	M	C. F. Brown.
Leith, N.B.	Scot.	M	J. R. Findlay.
Leitrim (County)	I.	M	E. O'N. Clarke.
Lerwick	Scot.	M	G. H. McGregor.
Lewes	S.E.	M	H. Card.
Lewisham	Met.	M	E. Van Putten.
Lewisham	Met.	AM	W. R. Davidge.
Leyland	N.W.	M	M. H. Wilkinson.
Leyton	E.	M	E. H. Essex.
Leyton	E.	AM	W. Jennings.
Leyton	E.	AM	J. W. Trodd.
Leytonstone	E.	M	L. W. Hogbin.
Lichfield	W.M.	M	W. B. Chancellor.
Lichfield	W.M.	AM	F. Stanyer.
Lichfield (Rural)	W.M.	AM	C. O. Rawstron.
Limerick (County)	I.	M	J. Horan.
Lincoln (Holland) (County)	E.M.	M	T. J. Peacock.
Lincoln (Kesteven) (County)	E.M.	M	W. B. Purser.
Lincoln (Lindsey) (County)	E.M.	M	J. Thropp.
Lincoln	E.M.	M	R. A. MacBrair.
Lincoln	E.M.	AM	T. Palmer.
Linslade	E.	M	M. G. Gurney.
Litherland	N.W.	M	A. H. Carter.
Littleborough	N.W.	M	G. H. Wild.
Littlehampton	S.E.	M	H. Howard.
Liverpool	N.W.	M	J. A. Brodie.
Liverpool	N.W.	AM	F. J. K. Conway.
Liversedge	N.E.	M	A. Rothera.
Llandaff & Dinas Powis (Rural)	W.S.	AM	L. Holden.
Llandudno	W.N.	M	E. P. Stephenson.
Llandybie	W.S.	M	J. O. Parry.
Llanelly	W.S.	M	J. H. Montgomery.
Llantrissant (Rural)	W.S.	M	G. S. Morgan.
Loftus	N.E.	M	B. J. Wormleighton.
London (County)	Met.	M	J. E. Worth.
London (County)	Met.	M	J. P. Harris.
London (County)	Met.	M	R. M. Gloyne.
London (County)	Met.	M	G. W. Humphreys.
London (County)	Met.	AM	H. W. Line.

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TOWN.	DISTRICT.		NAME.
London (County)	Met.	AM	W. H. Pickin.
London (County)	Met.	AM	F. Reed.
London (County)	Met.	AM	E. Pritchard.
London (Water)	Met.	M	W. B. Bryan.
London	Met.	M	F. Sumner.
London	Met.	M	E. E. Finch.
London	Met.	M	G. D. Trusler.
London	Met.	M	T. H. Dunch.
London	Met.	M	C. Mayne.
London	Met.	AM	B. D. Tracy.
London (Port of)	Met.	M	A. P. Lambert.
London (Port of)	Met.	M	E. E. L. Vincent.
London (Port of)	Met.	M	C. R. S. Kirkpatrick.
Londonderry (County)	I.	M	C. L. Boddie.
Londonderry	I.	M	M. A. Robinson.
Long Eaton	E.M.	M	W. A. Harrison.
Longton	W.M.	M	J. W. Wardle.
Loughborough	E.M.	M	A. H. Walker.
Louth (County)	I.	M	J. M. C. Lyons.
Lower Bebington	N.W.	M	H. W. Corrie.
Lowestoft	E.	M	G. H. Hamby.
Lucknow (United Provinces)	Ind.	M	H. Lane Brown.
Ludlow	W.M.	M	J. A. Spreckley.
Lurgan	I.	M	H. Shillington.
Luton	E.	M	J. W. Tomlinson.
Lyme Regis	S.W.	M	F. H. McDonnell.
Lymm	N.W.	M	D. Mort.
Lytham	N.W.	M	A. J. Price.
Lytham	N.W.	AM	E. Pilling.

TOWN.	DISTRICT.		NAME.
Macclesfield	N.W.	M	S. C. Baggott.
Macclesfield (Rural)	N.W.	M	J. Thorpe.
Maidenhead	E.	M	R. S. Lloyd.
Madras	Ind.	M	F. A. Adlard.
Madras	Ind.	AM	H. W. Barker.
Maesteg	W.S.	M	S. J. Harpur.
Maesteg	W.S.	AM	W. H. Hughes.
Maidstone	S.E.	M	T. F. Bunting.
Maidstone (Rural)	S.E.	M	T. A. Busbridge.
Malden	S.E.	M	R. H. Jeffes.
Malden	S.E.	M	G. M. Seels.
Maldon	E.	M	T. R. Swales.
Malvern	W.M.	M	W. O. Thorp.
Manchester	N.W.	M	T. De C. Meade.
Manchester	N.W.	M	F. R. Gibbins.
Manchester	N.W.	M	G. Fitton.
Manchester	N.W.	M	C. E. Newton.
Manchester	N.W.	M	J. Swarbrick.
Manchester	N.W.	M	J. W. Wiles.
Manchester	N.W.	M	J. P. Wilkinson.

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TOWN.	DISTRICT.		NAME.
Manchester	N.W.	AM	P. A. Reece.
Manchester	N.W.	AM	G. H. Bayley.
Manchester	N.W.	AM	E. W. Booth.
Manchester	N.W.	AM	D. Furness.
Manchester	N.W.	AM	H. Mattinson.
Manchester	N.W.	AM	W. T. Retford.
Manchester	N.W.	AM	W. G. Harbottle.
Manchester	N.W.	AM	C. V. Richards.
Manchester	N.W.	AM	E. Wickenden.
Mannar, Ceylon	Ind.	AM	S. J. Kirby.
Mansfield	E.M.	M	T. P. Collinge.
Mansfield Woodhouse	E.M.	M	F. P. Cook.
Margate	S.E.	M	E. A. Borg.
Margate	S.E.	M	J. S. Sawdon.
Market Harborough	E.M.	M	H. G. Coales
Marlow	E.	M	T. N. W. Watts.
Marple	N.W.	M	D. J. Diver.
Marylebone	Met.	M	J. A. P. Waddington.
Marylebone	Met.	M	J. Gair.
Matara, Ceylon	Ind.	AM	H. K. De Kretser.
Matlock	E.M.	M	W. Jaffrey.
Mayo (County)	I.	M	J. J. Noonan.
Melbourne	A.	M	W. Calder.
Melford (Rural)	E.	M	W. Carver.
Melton Mowbray	E.M.	M	E. Jeeves.
Menai Bridge	W.N.	M	W. Owen.
Merthyr Tydvil	W.S.	M	T. F. Harvey.
Merthyr Tydvil	W.S.	AM	D. L. Jones.
Merton	S.E.	M	G. Jerram.
Mexborough	N.E.	M	G. F. Carter
Michelstown (Rural)	I.	M	P. Coughlan.
Middlesbrough	N.E.	M	S. E. Burgess.
Middlesex (County)	E.	M	H. T. Wakelam.
Middlesex (County)	E.	M	W. E. F. Crooke.
Middlesex (County)	E.	M	A. J. Lander.
Middlesex (County)	E.	AM	W. Ashbee.
Middleton	N.W.	M	W. Welburn.
Midhurst (Rural)	S.E.	M	A. G. Gibbs.
Mid-Lothian (County)	Scot.	M	R. Moir.
Midsomer Norton	S.W.	M	C. H. Sunderland.
Midsomer Norton	S.W.	M	W. F. Bird.
Minehead	S.W.	M	J. H. Woolston Smith
Monaghan (County)	I.	M	J. J. Hannigan.
Monmouth	W.S.	M	G. F. Grimwood.
Monmouthshire (County)	W.S.	M	W. Tanner.
Morecambe	N.W.	M	J. W. Hipwood.
Morley	N.E.	M	F. Turner.
Mossley	N.W.	M	R. H. Buckley.
Musselburgh, N.B.	Scot.	M	G. Landale.
Mutford & Lothingland (Rural)	E.	M	H. Blewitt.
Mynyddislwyn	W.S.	M	E. W. Edwards.

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TOWN.	DISTRICT.		NAME.
Nailsworth	S.	M	A. W. Callaway.
Nairobi, British East Africa	Af.	M	J. F. Davidson.
Nairobi, British East Africa	Af.	AM	W. B. Acton.
Nantyglo and Blaina	W.S.	M	W. J. Davies.
Neath	W.S.	M	D. M. Jenkins.
Neath (Rural)	W.S.	M	W. E. C. Thomas
Neath	W.S.	AM	A. H. V. Taylor.
Nelson	N.W.	M	W. Shackleton.
Nelson	N.W.	M	C. T. Copley.
Nelson (Water)	N.W.	M	S. Whitehead.
Nelson	N.W.	AM	A. V. Cole.
Nelson	N.W.	AM	W. Moser.
Nelson	N.W.	AM	F. W. Mozley.
Neston	N.W.	M	C. E. Senior.
New Brighton	N.W.	AM	F. D. Ward.
New Brunswick	A.	AM	G. F. Palmer.
New Mills	E.M.	M	W. C. Sheard.
Newark	E.M.	M	J. Saunders.
Newark	E.M.	M	T. P. Frank.
Newark (Rural)	E.M.	M	R. Oakden.
Newburn-on-Tyne	N.E.	M	T. Gregory.
Newbury	S.	M	S. J. L. Vincent.
Newcastle-on-Tyne	N.E.	M	W. J. Steele.
Newcastle-on-Tyne	N.E.	M	J. E. Parker.
Newcastle-on-Tyne	N.E.	M	H. W. Taylor.
Newcastle-on-Tyne	N.E.	M	J. C. Midgley.
Newmarket	E.	M	W. H. Eley.
Newport, Mon.	W.S.	M	H. Tremelling.
Newport, Mon.	W.S.	AM	I. F. Shellard.
Newquay	S.W.	M	J. Ennor.
Newquay	S.W.	AM	A. D. Braggins.
Newry	I.	M	C. Blaney.
Newton Abbot	S.W.	M	C. D. White.
Newton Abbot (Rural)	S.W.	M	R. A. Rogers.
Newton-in-Makerfield (Water)	N.W.	M	R. T. Surtees.
Newtownards	I.	AM	J. L. Peacock.
Norfolk (County)	E.	M	W. A. Rogerson.
Norfolk (County)	E.	M	D. H. Steward.
North Shields	N.E.	M	J. P. Spencer.
North Vancouver	A.	M	R. Snodgrass.
Northampton (County)	E.	M	C. S. Morris.
Northampton (County)	E.	M	S. C. Percival.
Northampton	E.	M	A. Fidler.
Northampton	E.	AM	H. B. E. Brown.
Northampton	E.	AM	W. H. Letheren.
Northumberland (County)	N.E.	M	J. A. Bean.
Northwich	N.W.	M	J. Brooke.
Norwich	E.	M	A. E. Collins.
Norwich	E.	M	H. Collins.
Norwich	E.	M	W. G. Powell.
Norwich (Sewerage)	E.	AM	H. Wood.
Nottingham (County)	E.M.	M	E. P. Hooley.

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TOWN.	DISTRICT.		NAME.
Nottingham	E.M.	M	A. Brown.
Nottingham	E.M.	M	T. W. Gordon.
Nottingham	E.M.	AM	A. H. Elliott.
Nottingham	E.M.	AM	W. N. Thomas.
Nuneaton	W.M.	M	F. O. Cook.
Nuneaton	W.M.	AM	E. J. Goodacre.
Nuneaton	W.M.	M	R. C. Moon.
Oakham (Rural)	E.M.	M	W. S. Woodcock.
Oakham	E.M.	M	A. L. Parker.
Oakworth	N.E.	M	J. Spencer.
Okehampton	S.W.	M	F. J. Wordon.
Oldbury	W.M.	M	T. H. Shipton.
Oldham	N.W.	M	J. H. Bentley.
Oldham	N.W.	AM	R. B. Holden.
Ossett	N.E.	M	H. Holmes.
Ossett	N.E.	M	D. C. Thwaites.
Oswestry	W.M.	M	G. W. Lacey.
Otley	N.E.	M	C. F. Hodgson.
Ottawa	A.	AM	W. H. Carson.
Ottawa, Canada	A.	AM	L. McL. Hunter.
Oundle	E.	AM	B. L. Siddons.
Oxford	S.	M	W. H. White.
Oxford	S.	M	J. F. Richardson.
Oxfordshire (County)	S.	M	S. Stallard.
Oystermouth	W.S.	M	W. P. Puddicombe.
Paddington	Met.	M	E. B. B. Newton.
Paddington	Met.	AM	W. B. Smith.
Padiham	N.W.	M	J. Gregson.
Paignton	S.W.	M	C. O. Baines.
Paignton	S.W.	M	F. W. E. Vanstone.
Paignton	S.W.	M	J. A. Hutchinson.
Paisley	Scot.	M	J. Lee.
Paisley	Scot.	AM	M. Reid.
Peebles (County)	Scot.	M	R. S. Anderson.
Pemberton	N.W.	M	G. Heaton.
Pembroke Dock	W.S.	M	H. R. Crabb.
Penang	A.	M	L. M. Bell.
Penang	A.	M	C. G. May.
Penang	A.	AM	O. H. Wait.
Penarth	W.S.	M	E. I. Evans.
Penge	S.E.	M	H. W. Longdin.
Penrith	N.W.	M	J. J. Knewstubb.
Perth	Scot.	M	R. McKillop.
Perth	Scot.	M	T. McLaren.
Perthshire, West (County) ..	Scot.	M	W. L. Gibson.

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TOWN.	DISTRICT.		NAME.
Peterborough	E. ..	M ..	J. W. Walshaw.
Peterborough	E. ..	M ..	C. A. Gill.
Peterborough (County)	E. ..	M ..	A. C. Wallingford.
Pinner	E. ..	M ..	G. Weston.
Plymouth	S.W. ..	M ..	J. Paton.
Plymouth	S.W. ..	AM ..	J. Wibberley.
Plumstead Common	Met. ..	AM ..	W. T. Schlund.
Pokesdown	S. ..	M ..	E. W. Ingamells.
Pollokshaws	Scot. ..	M ..	D. Burns.
Pontardawe (Rural)	W.S. ..	M ..	J. Morgan.
Pontefract	N.E. ..	M ..	J. E. Pickard.
Pontypridd	W.S. ..	M ..	W. E. Lowe.
Pontypridd	W.S. ..	AM ..	G. L. Morgan.
Pontypridd	W.S. ..	AM ..	D. S. Williams
Poole	S.W. ..	M ..	S. J. Newman
Poplar	Met. ..	M ..	H. Heckford.
Poplar	Met. ..	AM ..	W. P. Wrack.
Port Elizabeth, South Africa	Af. ..	M ..	A. S. Butterworth.
Port Glasgow	Scot. ..	M ..	J. Murray.
Port Said	Af. ..	M ..	C. C. Brown.
Portadown	I. ..	M ..	W. Wilson.
Porthcawl	W.S. ..	M ..	A. J. Oborn.
Portishead	S.W. ..	M ..	F. H. Smith.
Portland	S.W. ..	M ..	R. S. Henshaw.
Portslade-by-Sea	S.E. ..	M ..	A. T. Allen.
Portsmouth	S. ..	M ..	G. Cowan.
Portsmouth	S. ..	M ..	R. J. Jenkins.
Prestatyn	W.N. ..	M ..	F. Wilkinson.
Preston	N.W. ..	M .	J. S. Bullough.
Preston	N.W. ..	M ..	H. Nuttall.
Prestwich	N.W. ..	M ..	S. H. Morgan.
Pretoria	Af. ..	M ..	T. W. Stainthorpe.
Pretoria (P.W.D.)	Af. ..	M ..	R. Robertson.
Pretoria (Water)	Af. ..	M ..	J. Riley.
Putney	Met. ..	M ..	J. C. Radford.
Ramsbottom	N.W. ..	M ..	T. H. Bell.
Ramsbury (Rural)	S. ..	M ..	W. Strickland.
Ramsgate	S.E. ..	M ..	T. G. Taylor.
Ramsey	E. ..	M ..	P. S. Bennett.
Rangoon	A. ..	M ..	L. P. Marshall.
Rangoon	A. ..	M ..	W. Bennett.
Rawmarsh	N.E. ..	AM ..	J. A. Tonge.
Rawtenstall	N.W. ..	M ..	J. Johnson.
Rawtenstall	N.W. ..	M ..	P. Holt.
Reading	S. ..	M ..	R. H. H. Watson.
Redcar	N.E. ..	M ..	J. Howcroft.
Redditch	W.M. ..	M ..	A. J. Dickinson.
Redruth	S.W. ..	M ..	W. J. Merrett.
Regina, Canada	A. ..	M ..	R.O.Wynne Roberts.

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TOWN.	DISTRICT.		NAME.
Reigate	S.E.	M	F. T. Clayton
Renfrewshire	Scot.	M	R. Drummond.
Renfrewshire (County)	Scot.	M	J. Murray.
Rhondda	W.S.	M	W. J. Jones.
Richmond	S.E.	M	J. H. Brierley.
Richmond	S.E.	M	W. Fairley.
Richmond	S.E.	AM	W. G. Cross.
Richmond	S.E.	AM	S. G. Turner.
Rickmansworth	E.	M	A. Freeman.
Rio de Janiero	A.	AM	T. O. Richardson.
Ripley	E.M.	AM	G. E. Fryer.
Ripon	N.E.	AM	A. Barlow.
Rochdale	N.W.	M	S. S. Platt.
Rochdale	N.W.	M	H. Yarwood.
Rochdale	N.W.	M	R. R. Jones.
Rochdale	N.W.	AM	J. R. Hill.
Rochester	S.E.	M	W. Banks.
Rochester	S.E.	M	S. Sills.
Rochford (Rural)	E.	M	H. T. Sidwell.
Rotherham	N.E.	M	E. B. Martin.
Rotherham	N.E.	M	T. Salvin.
Rotherham (Rural)	N.E.	M	F. C. Jenkinson.
Rotherham	N.E.	AM	E. H. Radcliffe.
Rothwell	N.E.	M	J. Southwart.
Rowley Regis	W.M.	M	W. H. Brettell.
Rugeley	W.M.	M	W. E. Rogers.
Ruislip-Northwood	E.	M	W. L. Carr.
Runcorn	N.W.	M	J. Wilding.
Rushden	E.	M	W. B. Madin.
Rutland (County)	E.M.	M	J. Richardson.
Ryton-on-Tyne	N.E.	M	J. P. Dalton.

TOWN.	DISTRICT.		NAME.
Saffron Walden	E.	M	A. H. Forbes.
St. Albans	E.	M	J. Ashurst.
St. Andrews	Scot.	M	W. Watson.
St. Austell (Water)	S.W.	M	E. D. Groves.
St. Catharines, Ontario	A.	M	R. D. Brown.
St. Germans (Rural)	S.W.	M	A. H. Hosking.
St. Helens (I. of W.)	S.	M	A. S. Lilley.
St. Helens, Lancs.	N.W.	M	A. W. Bradley.
St. Helens, Lancs.	N.W.	AM	C. Greenwood.
St. Ives (Water)	S.W.	M	S. Palmer.
St. Neots	E.	M	J. Edey.
St. Pancras	Met.	M	W. N. Blair.
St. Pancras	Met.	M	E. W. Swinstead.
Sale	N.W.	M	W. Holt.
Salford	N.W.	M	T. W. B. Gent.
Salford	N.W.	AM	J. Openshaw.
Salford	N.W.	AM	A. P. Statham.
Salisbury	S.	M	W. J. Goodwin.

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TOWN.	DISTRICT.		NAME.
Saltburn-by-the-Sea	N.E.	M	J. Draper.
Sandown, I. W.	S.	M	L. G. Daspher.
Sandown, I.W.	S.	AM	F. G. Coates.
Saxmundham	E.	M	J. E. Hattersley.
Scarborough	N.E.	M	H. W. Smith.
Scarborough	N.E.	M	H. Richardson.
Scarborough (Rural)	N.E.	M	J. A. Iveson.
Sculcoates (Rural)	N.E.	M	C. G. Wellsted.
Scunthorpe	E.M.	M	C. C. Gray.
Seaford	S.E.	M	B. A. Miller.
Secoondee, Gold Coast	Af.	M	A. G. Whitfeild.
Sedbergh (Rural)	N.E.	M	E. Park.
Sedgfield, Co. Durham (Rural)	N.E.	M	J. Stones.
Selkirk	Scot.	M	J. Pritty.
Sevenoaks	S.E.	M	S. Towlson.
Shanghai	A.	M	C. H. Godfrey.
Shanghai	A.	M	J. E. Needham.
Shanghai	A.	AM	H. E. Pollard.
Shanklin	S.	M	E. O. Cooper.
Sheffield	N.E.	M	C. F. Wike.
Sheffield (Highways)	N.E.	M	W. J. Hadfield.
Sheffield	N.E.	AM	W. C. Fenton.
Sheffield	N.E.	AM	J. Hassall.
Sheffield	N.E.	AM	A. C. Hodge.
Sheffield	N.E.	AM	S. H. Newsome.
Sheffield	N.E.	AM	F. Simms.
Sheffield (Highways)	N.E.	AM	E. W. Turner.
Sheringham	E.	M	F. Hall Smith.
Shifnal (Rural)	W.M.	M	G. H. Stevenson.
Shrewsbury	W.M.	M	W. O. Eddowes.
Shropshire (County)	W.M.	M	A. T. Davis.
Sierra Leone	A.	M	A. S. Bradshaw.
Sierra Leone	A.	M	W. S. Lake.
Sierra Leone	A.	M	G. Stanley.
Singapore	A.	M	R. Peirce.
Singapore	A.	M	B. Ball.
Singapore (Water)	A.	M	F. E. Marsh.
Singapore	A.	M	H. V. Towner.
Singapore (Water)	A.	M	S. G. Williams.
Skegness	E.M.	M	R. H. Jenkins.
Skipton	N.E.	M	A. E. W. Aldridge.
Skipton (Rural)	N.E.	M	A. Rodwell.
Sleaford	E.M.	M	S. F. Clare.
Sleaford	E.M.	M	J. Clare.
Slough	E.	M	W. W. Cooper.
Slough	E.	M	J. Baker.
Smallthorne	W.M.	M	J. W. Deane.
Smethwick	W.M.	M	A. Hosken.
Solihull (Rural)	W.M.	M	A. E. Currall.
Somerset (County)	S.W.	M	H. T. Chapman.
South Shields	N.E.	M	L. Roseveare.
South Shields	N.E.	M	A. J. Denton.

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TOWN.	DISTRICT.		NAME.
South Shields (Rural)	N.E.	M	T. T. Bains.
South Stoneham (Rural)	S.	M	F. Heather.
Southall Norwood	E.	M	R. Brown.
Southall Norwood	E.	AM	J. B. Thomson.
Southampton	S.	M	J. A. Crowther.
Southampton	S.	M	Sir J. Lemon.
Southampton	S.	M	H. J. Weston.
Southampton	S.	M	A. E. Dixon.
Southampton	S.	AM	J. H. Blizard.
Southampton	S.	AM	E. F. Harmer.
Southampton	S.	AM	E. E. Mann.
Southampton	S.	AM	W. H. Masters.
Southampton	S.	AM	R. Nicholls.
Southend-on-Sea	E.	M	E. J. Elford.
Southend-on-Sea	E.	M	R. H. Dyer.
Southend-on-Sea	E.	AM	C. C. Kidd.
Southend-on-Sea	E.	AM	E. J. Messent.
Southend-on-Sea	E.	M	H. C. Whitehead.
Southend-on-Sea	E.	AM	E. F. Edwards.
Southgate	E.	M	C. G. Lawson.
Southgate	E.	M	D. S. Sutherland.
Southgate	E.	AM	R. Phillips.
Southport	N.W.	M	R. P. Hirst.
Southport	N.W.	M	A. E. Jackson.
Southport	N.W.	AM	B. A. Nelson.
Southport	N.W.	AM	H. Goodfellow.
Southport	N.W.	M	G. Livingstone.
Southwark	Met.	M	A. Harrison.
Southwick	S.E.	M	G. W. Warr.
Southwick	S.E.	M	A. J. Catt.
Southwick-on-Wear	N.E.	M	W. B. Thomas.
Southwold	E.	M	J. S. Hurst.
Stafford (County) (Highways) ..	W.M.	M	J. Moncur.
Stafford	W.M.	M	W. Plant.
Stafford	W.M.	M	W. Blackshaw.
Staines	E.	M	E. J. Barrett.
Staines (Rural)	E.	M	G. W. Manning.
Staines (Rural)	E.	AM	A. C. Box.
Stalybridge	N.W.	M	J. N. White.
Stamford	E.M.	M	F. R. Ryman.
Stepney	Met.	M	M. W. Jameson.
Stepney	Met.	M	B. J. Belsher.
Stepney	Met.	AM	B. W. Stuttle.
Stepney	Met.	AM	C. A. Hazeltine.
Steyning, West (Rural)	S.E.	M	F. Slaughter.
Stirling	Scot.	M	A. H. Goudie.
Stockport	N.W.	M	J. Atkinson.
Stockport	N.W.	M	A. W. Ward.
Stockton-on-Tees	N.E.	M	M. H. Sykes.
Stockton-on-Tees	N.E.	M	G. C. Mitchell.
Stoke Newington	Met.	M	W. F. Loveday.
Stoke Newington	Met.	AM	A. W. Curry.

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TOWN.	DISTRICT.		NAME.
Stoke-on-Trent	W.M.	M	A. Burton.
Stoke-on-Trent	W.M.	M	J. R. Heath.
Stoke-on-Trent	W.M.	M	J. Lobley.
Stoke-on-Trent (Rural)	W.M.	M	R. Arrowsmith.
Stoke-on-Trent	W.M.	AM	H. Pool.
Stoke-on-Trent	W.M.	AM	J. W. Hill.
Stone	W.M.	M	A. R. Ridout.
Stourbridge	W.M.	M	F. Woodward.
Stourbridge	W.M.	M	W. Fiddian.
Stourbridge	W.M.	AM	A. Grove.
Stowmarket	E.	M	G. W. Lingwood.
Strand	Met.	AM	H. W. Cubitt.
Stratford	E.	AM	R. W. Burgess.
Stratford & Wolverton (Rural)	E.	M	A. E. Abbott.
Stratford-on-Avon	W.M.	M	R. Dixon.
Streatham	Met.	M	H. J. Marten.
Streatham Hill	Met.	AM	L. G. Roberts.
Stretford	N.W.	M	E. Worrall.
Stretford	N.W.	AM	E. Parker.
Stroud	S.	M	G. P. Milnes.
Sudbury	E.	M	W. I. Tait.
Suffolk, East (County)	E.	M	H. Miller.
Suffolk, East (County)	E.	M	S. C. Lloyd.
Suffolk, West (County)	E.	M	A. A. Hunt.
Sunbury-on-Thames	E.	M	H. F. Coales.
Sunderland	N.E.	AM	G. H. Whitaker.
Sunderland (Rural)	N.E.	M	T. Young.
Surbiton	S.E.	M	H. T. Mather.
Surrey (County)	S.E.	M	A. Dryland.
Surrey (County)	S.E.	M	F. Grove.
Sussex, East (County)	S.E.	M	F. J. Wood.
Sussex, East (County)	S.E.	AM	J. J. Barnes.
Sussex, West (County)	S.E.	M	H. W. Bowen.
Sussex, West (County)	S.E.	M	T. A. F. Phillips.
Sussex, West (County)	S.E.	M	W. Hosken.
Sutton, Surrey	S.E.	M	W. H. Grieves.
Sutton, Surrey	S.E.	AM	H. H. Cowlishaw.
Sutton, Surrey	S.E.	AM	W. Wright.
Sutton Coldfield	W.M.	M	W. A. H. Clarry.
Sutton Coldfield	W.M.	AM	F. W. Cross.
Sutton-in-Ashfield	E.M.	M	W. Burn.
Swadlincote	E.M.	M	T. Kidd.
Swanage	S.W.	AM	W. H. Pearce.
Swan Hill, Victoria	A.	AM	A. W. D. Brown.
Swansea	W.S.	M	G. Bell.
Swansea	W.S.	M	G. Swarbrick.
Swansea	W.S.	M	R. H. Wyrill.
Swansea	W.S.	AM	G. H. Bell.
Swansea (Rural)	W.S.	M	T. T. Williams.
Swindon	S.	M	H. J. Hamp.
Swinton	N.W.	M	H. Entwisle.
Sydney, New South Wales	A.	M	J. M. Smail.

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TOWN.	DISTRICT		NAME.
SYDNEY, NEW SOUTH WALES ..	A. ..	M ..	R. W. Richards.
SYDNEY, NEW SOUTH WALES ...	A. ..	AM ..	B. L. Siddons.
TADCASTER (Rural)	N.E. ..	M ..	H. C. Wood.
TADCASTER (Rural)	N.E. ..	M ..	H. M. Driver.
TADCASTER (Rural) (Highways) ..	N.E. ..	M ..	T. Scott.
TAMWORTH	W.M. ..	M ..	F. E. G. Bradshaw.
TAMWORTH (Rural)	W.M. ..	M ..	H. J. Clarson.
TANFIELD	N.E. ..	M ..	R. Heslop.
TAUNTON	S.W. ..	M ..	D. Edwards.
TE KUITI, NEW ZEALAND	A. ..	M ..	L. G. P. Spencer.
TEDDINGTON	E. ..	M ..	M. Hainsworth.
TEDDINGTON	E. ..	AM ..	O. S. Webb.
TEIGNMOUTH	S.W. ..	AM ..	C. D. H. Vanstone.
TENBURY (Rural)	W.M. ..	M ..	R. W. Jarvis.
TEWKESBURY	S.W. ..	M ..	W. Ridler.
THAMES CONSERVANCY BOARD ..	Met. ..	AM ..	T. Bradshaw.
THAMES DITTON	S.E. ..	AM ..	T. G. Newcomen.
THETFORD	E. ..	M ..	W. Jones.
THIRSK (Rural) (Highways) ..	N.E. ..	M ..	C. A. Lake.
THORNTON	N.W. ..	M ..	H. Fenton.
THORNTON HEATH	S.E. ..	AM ..	A. H. Quick.
TILBURY	E. ..	M ..	S. A. Hill Willis.
TIPTON	W.M. ..	M ..	W. H. Jukes.
TIVERTON	S.W. ..	M ..	J. Siddalls.
TIVERTON	S.W. ..	M ..	H. C. Poole.
TOBERMORY (County) (Highways)	Scot. ..	M ..	D. Cattanach.
TODMORDEN	N.E. ..	M ..	J. A. Heap.
TODMORDEN	N.E. ..	M ..	J. H. Williams.
TOKIO, JAPAN	A. ..	M ..	B. Kusakabe.
TOKIO, JAPAN	A. ..	M ..	R. Hara.
TOKIO, JAPAN	A. ..	M ..	S. Yonemoto.
TONBRIDGE	S.E. ..	M ..	W. L. Bradley.
TONBRIDGE (Rural)	S.E. ..	M ..	F. Harris.
TORONTO	A. ..	AM ..	R. Butler.
TORPOINT	S.W. ..	M ..	R. H. Beaumont.
TORQUAY	S.W. ..	M ..	H. A. Garrett.
TORQUAY	S.W. ..	M ..	C. Gillard.
TOTTENHAM	E. ..	M ..	W. H. Prescott.
TOTTENHAM	E. ..	AM ..	H. F. Wilkinson.
TOTTINGTON	N.W. ..	M ..	L. Kenyon.
TOWYN	W.N. ..	M ..	R. P. Morgan.
TRINCOMALEE	Ind. ..	AM ..	C. A. Coombs.
TRING	E. ..	M ..	S. S. Gettings.
TROWBRIDGE	S. ..	M ..	H. G. N. Lailey.
TULLAMORE	I. ..	M ..	A. V. Ashe.
TUNBRIDGE WELLS	S.E. ..	M ..	W. H. Maxwell.
TURTON	N.W. ..	M ..	V. Laithwaite.
TUTBURY (Rural)	W.M. ..	M ..	H. T. Tebbitt.
TWICKENHAM	E. ..	M ..	F. W. Pearce.
TWICKENHAM	E. ..	M ..	G. R. King.
TWICKENHAM	E. ..	AM ..	A. Wintle.

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TOWN.	DISTRICT.		NAME.
TWRCELYN (Rural)	W.M. ..	M ..	W. F. Brindle.
TYLDESLEY	N.W. ..	M ..	F. E. Jones.
TYNEMOUTH	N.E. ..	M ..	J. F. Smillie.
TYRONE, SOUTH (County)	I. ..	M ..	J. W. Leebody.
UMTATA, CAPE COLONY	Af. ..	M ..	E. J. D. Brooks.
URMSTON	N.W. ..	M ..	J. Heath.
UTTOXETER	W.M. ..	M ..	J. R. Hadfield.
UXBRIDGE (Rural)	E. ..	M ..	J. W. Harrison.
UXBRIDGE	E. ..	M ..	E. Birks.
VANCOUVER, BRITISH COLUMBIA	A. ..	M ..	A. J. Henderson.
VANCOUVER, NORTH	A. ..	M ..	R. Snodgrass.
VENTNOR	S. ..	M ..	H. H. Oakes.
WAKEFIELD (County)	N.E. ..	M ..	W. E. H. Burton.
WAKEFIELD	N.E. ..	M ..	J. P. Wakeford.
WAKEFIELD (Rural)	N.E. ..	M ..	F. Massie.
WAKEFIELD	N.E. ..	M ..	L. Ives.
WAKEFIELD	N.E. ..	AM ..	A. E. Loach.
WALLASEY	N.W. ..	M ..	W. H. Travers.
WALLASEY	N.W. ..	M ..	J. S. Walker.
WALLASEY	N.W. ..	AM ..	Thomas Jones.
WALLASEY	N.W. ..	AM ..	J. S. McGlashan.
WALMER	S.E. ..	M ..	H. W. Barker.
WALSALL	W.M. ..	M ..	J. Taylor.
WALSALL (Rural)	W.M. ..	M ..	W. P. Young.
WALSALL	W.M. ..	AM ..	C. F. Nightingale.
WALSALL	W.M. ..	AM ..	G. W. Teasdale.
WALSALL	W.M. ..	AM ..	G. Dyke.
WALTHAM CROSS	E. ..	M ..	W. C. Holloway.
WALTHAMSTOW	E. ..	M ..	E. Morley.
WALTHAMSTOW	E. ..	M ..	G. W. Holmes.
WALTHAMSTOW	E. .	M ..	J. Neave.
WALTHAMSTOW	E. ..	AM .	J. W. Mason.
WALTON-ON-THAMES	S.E. ..	M ..	R. Wilds.
WANDSWORTH	Met. ..	M ..	P. Dodd.
WANTAGE (Rural)	S. ..	M ..	J. W. Harris.
WARE	E. ..	M ..	H. F. Hill.
WARMINSTER	S. ..	M ..	C. H. Lawton.
WARMINSTER (Rural)	S. ..	AM ..	C. C. Hancock.
WARMLEY (Rural)	S. ..	M ..	M. E. W. Fitzgerald.
WARRAMBOOL (Water)	A. ..	M ..	J. C. Ross.
WARRINGTON	N.W. ..	M ..	A. M. Ker.
WARRINGTON	N.W. ..	M ..	M. A. Piercy.
WARWICKSHIRE (County)	W.M. ..	M ..	J. Willmot.
WATERFORD (County)	I. ..	M ..	W. E. L. Duffin.
WATERFORD	I. ..	M ..	J. J. Fleming.
WATERLOO	N.W. ..	M ..	F. S. Yates.

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TOWN.	DISTRICT.		NAME.
Watford	E.	M	D. Waterhouse.
Watford	E.	M	W. W. Newman.
Watford	E.	AM	W. Hy. Duckworth.
Wath-upon-Dearne	N.E.	M	J. H. Drew.
Wealdstone	E.	M	H. Walker.
Wellingborough	E.	M	E. Y. Harrison.
Wellingborough	E.	AM	B. Archer.
Wellington, New Zealand	A.	M	R. S. Rounthwaite.
Wellington, Salop	W.M.	M	G. Riley.
Wellington, Salop	W.M.	AM	W. J. Goode.
Wembley	E.	M	C. R. W. Chapman.
West Bromwich	W.M.	M	A. D. Greatorex.
West Bromwich	W.M.	M	D. Ellison.
West Hartlepool	N.E.	M	N. F. Dennis.
West Hartlepool	N.E.	M	E. J. Miles.
West Hartlepool	N.E.	AM	F. Durkin.
West Ward, Westmorland	N.W.	M	P. M. Hope.
Westminster	Met.	M	H. P. Maybury.
Westminster	Met.	M	H. P. Boulnois.
Westminster	Met.	M	C. Dunscombe.
Westminster	Met.	M	E. B. Ellice-Clark.
Westminster	Met.	M	E. J. Silcock.
Westminster	Met.	M	C. Chambers Smith.
Westminster	Met.	M	L. J. Veit.
Westminster	Met.	M	Sir A. R. Binnie.
Westminster	Met.	M	A. Ventris.
Westminster	Met.	M	T. J. Moss-Flower.
Westminster	Met.	M	A. P. I. Cotterell.
Westminster	Met.	M	Sir M. Fitzmaurice.
Westminster	Met.	M	J. S. Killick.
Westminster	Met.	AM	R. Blakeway-Phillips.
Westminster	Met.	AM	C. Connor.
Westminster	Met.	AM	H. M. de Colville.
Westminster	Met.	AM	G. P. Knowles.
Westminster	Met.	AM	K. G. MacDonald.
Westminster	Met.	AM	E. Thomas.
Weston-super-Mare	S.W.	M	H. A. Brown.
Weybridge	S.E.	M	J. S. Crawshaw.
Weymouth	S.W.	M	W. B. Morgan.
Weymouth	S.W.	M	K. H. S. Harris.
Weymouth	S.W.	AM	J. B. Bradshaw.
Whitchurch	W.M.	M	M. Sowden.
Whitehaven	N.W.	M	E. E. Stiven.
Whitehaven	N.W.	M	W. H. Beswick.
Whitehaven	N.W.	AM	A. J. McArd.
Whitley and Monkseaton	N.E.	M	A. J. Rousell.
Wicklow	I.	M	J. Pansing.
Widnes	N.W.	M	J. S. Sinclair.
Wigan	N.W.	M	A. T. Gooseman.
Wigston Magna	E.M.	M	W. G. J. Clark.
Wigton (Rural)	N.W.	M	T. B. Simmons.
Willenhall	W.M.	M	T. E. Fellows.

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TOWN.	DISTRICT.		NAME.
Willenhall	W.M.	AM	H. J. Tonks.
Willesden	E.	M	O. C. Robson.
Willesden	E.	M	B. Haylor.
Willesden	E.	AM	J. H. Smyth.
Willesden	E.	AM	W. J. Smith.
Wilmslow	N.W.	M	A. S. Cartwright.
Wilton (Rural)	S.W.	M	R. A. Skelton.
Williton	S.W.	AM	R. J. Hake.
Wilts (County)	S.	M	J. George-Powell.
Wimbledon	S.E.	M	F. Wilkinson.
Winchester	S.	M	W. V. Anderson.
Winchester (Rural)	S.	M	G. E. Carter.
Windermere	N.W.	M	C. E. Hines.
Windsor	S.	M	E. A. Stickland.
Winnipeg, Canada	A.	AM	A. J. Wills.
Wisbech	E.	M	E. E. Barlow.
Withington	N.W.	M	O. Hellawell.
Withington	N.W.	AM	I. Cunliffe.
Withington	N.W.	AM	F. W. Dean.
Withington	N.W.	AM	H. C. Swindells.
Wokingham	S.	M	C. W. Marks.
Wokingham	S.	AM	H. M. Lewis.
Wokingham	S.	AM	H. M. Lewis.
Wolverhampton	W.M.	M •	G. Green.
Wolverhampton	W.M.	M	F. G. Beaumont.
Wolverhampton	W.M.	M	R. E. W. Berrington
Wolverhampton	W.M.	AM	E. E. W. Berrington.
Wolverhampton	W.M.	AM	W. A. Hutchings.
Wood Green	E.	M	C. H. Croxford.
Wood Green	E.	M	W. H. Budgett.
Wood Green	E.	AM	R. H. Matthews
Woodford Green	E.	M	W. Farrington.
Woodford Green	E.	M	L. J. Small.
Woodhall Spa	E.	M	E. E. T. Bolton.
Woolwich	Met.	M	J. R. Dixon.
Worcester (County)	W.M.	M	C. F. Gettings.
Worcester	W.M.	M	T. Caink.
Worcester	W.M.	M	W. Ransom.
Worcester (County)	W.M.	AM	R. Fletcher.
Worcester (County) (Highways)	W.M.	AM	B. C. Hammond.
Workington	N.W.	M	H. B. Williams.
Worksop	E.M.	M	G. Rawson.
Worthing	S.E.	M	F. Roberts.
Worthing	S.E.	M	P. E. Harvey.
Worthing	S.E.	AM	A. G. A. Davies.
Wortley (Rural)	N.E.	M	G. E. Beaumont.
Wrexham	W.N.	M	J. England.
Wrexham (Rural)	W.N.	M	J. P. Evans.
Wrexham (Rural)	W.N.	M	J. H. Edwards.
Wynberg, Cape Colony (Water)	Af.	M	H. M. Ledell.

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TOWN.	DISTRICT.		NAME.
Yardsley-cum-Whaley	N.W. ..	M ..	W. Eyre.
Yeovil (Rural)	S.W. ..	M ..	L. Caplen.
York	N.E. ..	M ..	F. W. Spurr.
York	N.E. ..	M ..	C. Trifflitt.
York	N.E. ..	M ..	A. Creer.
York	N.E. ..	AM ..	R. H. Couzens.
York	N.E. ..	AM ..	S. M. Senior.
York	N.E. ..	AM ..	G. A. Ballard.
York	N.E. ..	AM ..	H. Anderson.
York	N.E. ..	AM ..	H. S. Thorpe.
Yorkshire, East Riding	N.E. ..	M ..	A. Beaumont.
Yorkshire, North Riding (County)	N.E. ..	M ..	W. G. Bryning.
Yorkshire, West Riding	N.E. ..	AM ..	J. R. R. Oddy.
Yorkshire, West Riding	N.E. ..	AM ..	W. Metcalfe.
Youghal	I. ..	M ..	H. Spreadborough.
Zanzibar	Af. ..	M ..	G. E. L. Poulden.
Zanzibar	Af. ..	M ..	L. K. Brindley.
Zanzibar Protectorate	Af. ..	M ..	A. R. Galbraith.

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MEMBERS OF THE ROAD SURVEYORS' ASSOCIATION OF SCOTLAND AFFILIATED TO THE INSTITUTION.

Date of Election.		
1912 Jan. 1	ALLAN, J.	County Road Surveyor, Huntley.
"	ATKINSON, T. R.	County Road Surveyor, Earlston, Berwickshire.
"	BALLANTINE, W.	County Road Surveyor, Lauriston, Falkirk.
"	BARTIE, J.	County Road Surveyor, Selkirk.
"	BELL, W.	County Road Surveyor, Aberfeldy.
"	CALLEN, R.	County Road Surveyor, Dunoon.
"	CALLEN, T.	County Road Surveyor, Haddington.
"	CLARKE, P.	County Road Surveyor, Dunbar.
"	COX, D. R.	County Road Surveyor, Stirling.
"	CRAM, P. McF.	County Road Surveyor, Nairn.
"	DONALDSON, G.	County Road Surveyor, Kirkcaldy.
"	ELLACOTT, W.	County Road Surveyor, Bonnyrigg, Mid Lothian.
"	GIBSON, W. K.	County Road Surveyor, Stranraer.
"	GOODWILLIE, A.	County Road Surveyor, Brechin.
"	GOODWILLIE, T.	County Road Surveyor, St. Andrews.
"	GRAHAM, W. N.	County Road Surveyor, Hawick.
"	GRANT, A. M.	County Road Surveyor, Kingussie.
"	HOGG, C. G.	County Road Surveyor, Dingwall.
"	HUNTER, J. M.	County Road Surveyor, Timber Green, Arbroath.

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Date of Election.		
1912 Jan. 1	Kirkland, J.	County Road Surveyor, Ormiston Villa, Kirknewton, Mid-Lothian.
,,	Kirkpatrick, J.	County Road Surveyor, Duns.
,,	Lang, J.	County Road Surveyor, Kilmarnock.
,,	Lapham, J. D.	County Road Surveyor, Linlithgow.
,,	McBain, W.	County Road Surveyor, Kelso.
,,	McGregor, J. M.	County Road Surveyor, Maybole, Ayrshire.
,,	MacKenzie, J.	County Road Surveyor, Portree.
,,	Mackintosh, C. J. M.	County Road Surveyor, Fort William.
,,	Macrae, K.	County Road Surveyor, Oban.
,,	Paterson, R...	County Road Surveyor, Beattock, Lockerbie.
1914 Jan. 1	Ramsey, T. Y.	County Road Surveyor, Bathgate, Linlithgow.
1912 Jan. 1	Rankin, J. S...	County Road Surveyor, Thornhill, Dumfries.
,,	Robb, D. H.	County Road Surveyor, Wigtown.
,,	Roberton, A.	County Road Surveyor, Crieff.
,,	Roberton, J. B.	County Road Surveyor, Downfield, Dundee.
,,	Robertson, D.	County Road Surveyor, Alford, Aberdeenshire.
,,	Scott, J.	County Road Surveyor, Perth.
,,	Shields, D.	District Surveyor, Fakenham, Norfolk.
,,	Wyllie, G.	County Road Surveyor, Blairgowrie.
,,	Wyllie, W.	County Road Surveyor, Ross-shire. Tain.

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MEMBERS OF THE ASSOCIATION OF COUNTY SURVEYORS OF IRELAND AFFILIATED TO THE INSTITUTION.

Date of Election.		
1913 Jan. 1	Barry, W. F.	County Surveyor, Wexford.
1913 Jan. 1	Dixon, E. K.	County Surveyor, Castlebar, Mayo.
1913 Jan. 1	Dobbin, P. L. K.	County Surveyor, Ennis, Clare.
1913 Jan. 1	Gallagher, S. G.	County Surveyor, Wicklow.
1913 Jan. 1	Glover, E.	County Surveyor, Naas, Co. Kildare.
1913 Jan. 1	Goodwin, S.	County Surveyor, Tralee, Kerry.
1913 Jan. 1	Hackett, E. A.	County Surveyor, Clonmel, Tipperary.
1913 Jan. 1	Joyce, A. E.	County Surveyor, Mullingar, Westmeath.
1913 Jan. 1	Kirwan, R. J.	County Surveyor, Sligo.
1913 Jan. 1	Moran, J.	County Surveyor, Galway.
1913 Jan. 1	Moynan, J. O.	County Surveyor, Nenagh, Tipperary.
1914 Jan. 1	Mulvany, C.	County Surveyor, Co. Roscommon. Ranelagh House, Roscommon.
1913 Jan. 1	Murphy, J. T.	County Surveyor, Cork.
1913 Jan. 1	O'Connor, R. F.	County Surveyor, Mallow, Cork.
1913 Jan. 1	O'Sullivan, L. J.	County Surveyor, Tullamore, King's County.
1913 Jan. 1	Punch, J. P.	County Surveyor, Carlow.
1913 Jan. 1	Quigley, J.	County Surveyor, Navan, Meath.
1913 Jan. 1	Somerville, R. N.	County Surveyor, Cavan.
1913 Jan. 1	Walsh, T.	County Surveyor, Maryborough, Queen's County.

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STUDENTS.

[Stud. Inst. M. & Cy. E.]

Date of Election.		
1912 July 11	ADAMSON, R. A.	Town Hall, Chiswick, W.
1913 Apr. 19	ALLEN, T. F.	Admiralty Offices, H.M. Dockyard, Rosyth.
1913 Sept. 6	ARCHER, R.	Borough Engineer's Office, Brighouse.
1912 Apr. 27	ASHBY, A. W.	1 Hencroft Street, Slough, Bucks.
1913 Sept. 6	ASHCROFT, H.	County Surveyor's Office, Preston, Lancs.
1912 Apr. 27	BISHOP, H. P.	The Housing Reform Co., 3 & 4 Park Place, Cardiff.
1912 Dec. 7	BLACKBURN, L. C.	4 Fremantle Road, Cotham, Bristol.
1912 Oct. 26	BLEAKLEY, E.	185 Elliott Street, Tyldesley.
1913 Jan. 4	BOLTON, V. E. R.	Surveyor's Office, Urban District Council, Bushey, Herts.
1913 Sept. 6	BOOTH, A.	Borough Surveyor's Office, Congleton.
1911 Oct. 21	BOWEN, J. S.	2 Oldbury Road, Greets Green, West Bromwich.
1912 Oct. 26	BRADLEY, H. E.	County Surveyor's Office, The Square, Barnstaple.
1913 Apr. 19	BROWN, C. R...	Borough Engineer's Office, Douglas, Isle of Man.
1911 Oct. 21	BRYAN, R. C.	Chapel House, West Street, Bourne, Lincs.
1912 Dec. 7	CADIC, B. F.	Borough Engineer's Office, Gillingham, Kent.
1912 Mar. 2	CHANDLER, G. W...	Lydney Park Estate Office, Lydney, Glos.
1911 Dec. 2	CHESTERFIELD, B. F.	Town Hall, Alton, Hants.
1912 Apr. 27	CLARKE, G. J.	Assistant Surveyor, Urban District Council, Epsom, Surrey.
1912 Sept. 9	CLIFFE, H.	Surveyor's Assistant, Urban District Council, Mexborough.
1913 May 24	COOK, G. H. H.	Borough Engineer's Office, Town Hall, Bridlington.
1912 Dec. 7	COPLEY, F. M.	Assistant Engineer, Town Hall, Wath-upon-Dearne.
1912 June 1	CUTTING, W. A.	Gas Works, Dunstable.

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Date of Election.		
1912 Dec. 7	DOBSON, W. H.	Borough Engineer's Office, Gillingham, Kent.
1912 Apr. 27	DOXEY, H. M.	93 Rumford Street. Chorlton-on-Medlock, Manchester.
1911 Oct. 21	FITCH, J. T.	City Engineer's Office, Council House, Birmingham.
1911 Oct. 21	FLOOD, A.	Borough Surveyor's Office, Municipal Offices, Gravesend.
1912 June 1	GRAVES, H. S.	Engineering Assistant, Surveyor's Office, Womburn, nr. Wolverhampton.
1912 Dec. 7	GRIFFIN, T. S.	Assistant Engineer, Preston Vale, Penkridge, Staffs.
1913 Mar. 15	GUILBERT, T. O.	Colborne Villa, Rohais, Guernsey.
1912 Jan. 13	HARDIE, N.	57 Bradford Road, Gt. Lever, Bolton.
1913 Jan. 4	HARRISON, A. A.	Borough Engineer's Office, Town Hall, Preston, Lancs.
1913 Feb. 8	HARRISON, P.	"Wharfedale," Myddleton Road, Uxbridge.
1911 Oct. 21	HASELDINE, W. S. T.	Beech House, Answorth, Notts.
1911 Oct. 21	HEALE, C. H. R.	St. Peter's Vicarage, Williton, Taunton.
1913 Apr. 19	HEATH, R. S.	Borough Engineer's Office, Cambridge.
1913 July 16	HODGKISS, E.	Surveyor's Office, Town Hall, Worsley, Lancs.
1912 July 11	HODSON, C. F.	26 Victoria Street, Grimsby.
1913 Feb. 8	HOGSDEN, R. R.	Council Offices, Midhurst, Sussex.
1913 Apr. 19	HOMAN, G. G.	Borough Engineer's Office, Gillingham, Kent.
1913 Sept. 6	HUDSON, W.	Borough Engineer's Office, Bridlington.
1912 Feb. 10	IMPEY, L. R.	Town Hall, Sudbury, Suffolk.
1913 Feb. 8	JENKINS, A. O.	Burgh Surveyor's Office, Town Hall, Dumfries.
1913 Sept. 6	JENKINSON, DOUGLAS	Surveyor's Office, Rural District Council, Imperial Buildings, Rotherham.

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Date of Election.		
1912 Jan. 13	KERSHAW, GYLBERT	25 Grange Road, Canonbury, N.
1912 Sept. 9	KERSHAW, G...	28 Hamilton Road, Highbury Park, N.
1913 July 16	KHOSLA, HAR DYAL	3 Glazebury Road, Baron's Court, W.
1913 Mar. 15	KING, A. J.	Town Hall, Devizes, Wilts.
1913 May 24	KIRBY, F.	Assistant Surveyor to the Rural District Council, Sedgefield, Co. Durham.
1913 Apr. 19	LAWRENCE, A. E.	Engineering Assistant, City Surveyor's Office, Hereford.
1912 Jan. 13	LEADBEATER, H.	"New Zealand," Bridgegate, Rotherham.
1912 Dec. 7	MACBRAIR, D. M...	City Engineer's Office, Lincoln.
1913 Mar. 15	MCQUEEN, P. C.	Town Hall, Beccles.
1913 May 24	MCRAE, F. N.	Engineer's Dept., Town Hall, Hampstead, N.W.
1911 Dec. 2	MASON, S.	118 Stirling Street, Grimsby.
1913 Apr. 19	MOORES, R. J.	Council Offices, Hampton.
1912 Jan. 13	MOULE, E. S.	Borough Engineer's Office, Town Hall, Luton.
1913 Feb. 8	MULLISS, E. J.	County Surveyor's Office, Shire Hall, Hereford.
1913 Jan. 4	NOBLET, T. W.	Junior Assistant Surveyor, Rural District Council, Preston, Lancs.
1911 Dec. 2	NORTH, R. W.	25 Carlton Road, Worksop.
1911 Oct. 21	PAIN, W. S.	73 Penfold Road, Folkestone.
1913 Apr. 19	PHILLIPS, T. W.	Borough Engineer's Office, Bexhill-on-Sea.
1913 July 16	PIDGEON, G. A.	Surveyor's Office, Town Hall, Alton, Hants.
1912 Apr. 27	PIGGOTT, A. P.	Town Hall, Stoke Newington.
1911 Oct. 21	PONSFORD, G...	Assistant Surveyor, Rural District Council, Bridgwater. 56A Eastover, Bridgwater.
1911 Dec. 2	PRESCOTT, E.	"Cavendish House," Kirkdale Lane, Leigh, Lancs.
1913 Jan. 4	PRESTON, N. D.	Surveyor's Office, Town Hall, Ulverston.
1911 Oct. 21	PRICE, W. H...	Sewerage Engineer's Office, Gt. George Street, Leeds.
1913 Sept. 6	PROUD, S. S.	Assistant Surveyor to the Rural District Council, Sedgefield.
1913 May 24	RAWNSLEY, T. H.	Borough Surveyor's Office, Town Hall, Ossett.
1913 June 21	RHODES, C. S...	Engineering Assistant, Borough Engineer's Office, Accrington.

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Date of Election.		
1913 Mar. 15	Richardson, H. M.	Surveyor's Office, Cowes Urban District Council, Isle of Wight.
1913 Feb. 8	Roberts, G. V.	County Surveyor's Office, Shire Hall, Hereford.
1913 July 16	Rodgers, F.	Surveyor's Office, Urban District Council, Gainsborough.
1913 Apr. 19	Scott, Jnr., T. W. . ..	Public Offices, Enfield.
1912 June 1	Shaw, J. S.	Borough Engineer's Office, Wrexham.
1913 Sept. 6	Shaw, S. T.	Assistant Surveyor to the Rural District Council, Imperial Buildings, Rotherham.
1913 May 24	Slayton, H .V.	City Engineer and Surveyor's Office, Lincoln.
1911 Dec. 2	Stephens, F. B. J.	Council Offices, Bognor, Sussex
1912 Sept. 9	Taylor, R. W.	Nelson Terrace, Unicorn Road, Portsmouth.
1912 Feb. 10	Thomson, C. B.	City Surveyor's Office, Town Hall, Manchester.
1911 Oct. 21	Tolputt, H. St. G.	"Deepdene," Brockhill Road, Saltwood, Kent.
1912 July 11	Walker, W. A.	Borough Surveyor's Office, Mansion House, Doncaster.

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THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.

ANNUAL MEETING IN LONDON.

July 11, 12, and 13, 1912.

Held at Caxton Hall, Westminster.

ROBERT J. THOMAS, M.Inst.C.E., President.

THE PRESIDENT'S ADDRESS.

The recent confirmation by the Court of the Amended Memorandum of Association has brought to a conclusion the labours of your Council, and particularly of the Constitution Committee, which, presided over by its indefatigable chairman, Mr. J. Patten Barber, considered in minutest detail various suggestions and proposals having as their objective the improvement of the professional status of members, and of the Institution's position among kindred societies.

In such an organisation as ours there must necessarily be varied opinions and convictions relative to the best methods for hastening its development in practical utility and power; were it not so the incentive to progress and activity would be absent. Recent events have shown many divergent views in matters of detail affecting our welfare, but, inspired by the predominant desire to promote the best interests of the Institution, mutual

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concessions have been made, and I have every faith that the amendments agreed to will be accorded hearty and loyal support by our members.

It is to be regretted that some of the recommendations made by the Council, and adopted by the members, failed to secure the approval of the Government department having the power of veto, and had therefore to be amended in accord with its requirements; but it is confidently believed that the memorandum as now sanctioned will materially assist the Institution in its efforts to advance the interests of its members individually and collectively. That this belief should prove well founded is my earnest desire, particularly in the interests of our younger members, to whom belongs the future of the Institution.

District Representation.

We are entering upon the new system of district representation adopted by the members, and I fully believe that such alterations cannot fail to yield beneficial results, by stimulating local effort, encouraging intercourse between members located in each district where, presumably, many of the conditions and difficulties are common to all, and, by frequent meetings, bringing members into closer touch and within reach of that personal support and intercourse which so materially assists and encourages an engineer, who has perforce to carry out his arduous duties in professional isolation during the greater part of the year.

It will no doubt require time to secure perfect working of the new arrangement, but, with energetic district officers and committees, and whole-hearted support from their constituents, its benefits and advantages must, at an early date, produce substantial results, enhance the value of the Institution to its members, and improve its position in the local government of the kingdom.

It is desirable that meetings be arranged in each district at the earliest possible date, to elect committees and determine the working arrangements. The discussion to be raised during this meeting should materially assist district officers in these preliminaries.

The Institution Examinations.

It is most encouraging to find that the number of candidates presenting themselves for examinations held by the Institution

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is well maintained, although the educational qualifications required before applications to sit can be granted are now in accord with the requirements of modern professional life; as a consequence, there is an obvious improvement in the general quality and form of the answers given in the examinations, affording abundant promise of future distinction to the candidates and dignity to this Institution.

To one who found the testamur of the utmost value at a critical period in his early career, nothing in the work of the Institution appeals with greater force than these examinations, and I trust that members will continue to afford every opportunity to their assistants to prepare for and take part in them.

It is desirable to inform parents of prospective pupils that certain scholastic credentials are necessary prior to obtaining permission to sit for the examination, and that it is generally easier for a youth to obtain these before leaving school or immediately after than later.

Superannuation and State Protection of Officials.

Superannuation is still unattained, although the National Association of Local Government Officers continues its efforts, supported by subscriptions and delegates from this Institution; but, although recent rumours of early attainment may be too optimistic, it is difficult to comprehend how some public officials can longer be excluded from benefits granted to others having no more arduous or responsible duties to perform. It is much to be hoped that Imperial Parliament may make time to consider the long-overdue claims of local government, of which adequate superannuation of all officials who have given of their best to the common weal should form an early instalment.

No less important is the provision of State protection for officials whose duties inevitably bring them at times into conflict with those who endeavour to evade the requirements of public authorities, and who, having influence with members, and even themselves sitting upon such bodies, are prone to make a conscientious official's life a burden to him, and often succeed in securing his dismissal, unless he is prepared to abandon his principles and betray the trust placed in him by his employers.

It is too true that there are many instances of this in smaller towns and districts, where the emoluments are so small

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that the official is sorely tried in his efforts to provide honourably for those dependent upon him. That such cases should exist is an anomaly, as Departments of State which sanction loans, by-laws and regulations should afford protection to those officials responsible for their observance, and who, upon adequate investigation, are found to have carried these duties out faithfully and impartially.

Having had experience of the difficulties attached to communications and interviews with authorities whose treatment of their surveyors was, in the opinion of your Council, such as to warrant protest, I am strongly of opinion that in a very large majority of cases this interposition of an Institution having practically no executive power can secure but little relief to the officer, however cautiously and tactfully this interference between employer and employed is effected.

It is essential that either this Institution should have far larger powers in this direction, or that the State should afford our profession the measure of protection accorded to others.

The opinion of our solicitor that the new memorandum of Association as amended by the Board of Trade precludes the use of the Institution's funds to defray the costs incurred by a member in a recent libel action is most disappointing, and members are justified in feeling their regret that this desirable power has been denied them.

The alternative appears to be an independent fund raised by annual subscriptions, and, as steps have been taken to formulate a scheme, I feel confident that for such a desirable object members will gladly subscribe, so that a substantial fund can be established upon which a representative committee can draw in support of all cases which, after due investigation, are found worthy of financial support.

Roads.

The past year has witnessed the active participation of the Road Board in the work upon our roads, and we can but regret that they are precluded from making any contribution towards the rapidly increasing maintenance charge. This presses especially hardly upon rural districts of small rateable value and encumbered with a large mileage of roads, many used in ever-increasing proportion by through traffic, heavy and rapid. The Board's contributions towards the extra cost of employing

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materials and methods more suited to modern traffic must gradually retard that rapid growth in expenditure experienced during recent years, when roads adequate and suitable for the traffic of ten to twelve years ago have been found unequal to the task of sustaining the phenomenal growth of self-propelled traffic, and the annual cost for maintenance of which has risen a million during that period.

The assistance afforded to Local Authorities in widening exceptionally narrow roads, and in opening out dangerous corners must be of general advantage to the travelling public, especially as the policy adopted of providing an unobstructed view across dangerous corners and at intersecting roads rather than rounding off such places, adds to the security of general traffic without facilitating more rapid negotiation of such corners.

That there are many difficulties to overcome and interests to be considered before the roads in this congested country can be straightened, widened and improved, so as to compare with those in countries of recent development, is exemplified by the divergent views expressed relative to the Board's offer of a contribution towards the provision of a new and adequate approach road to London from the west.

Although the Board's scope and powers are at present somewhat restricted, I believe the future will see important and far-reaching developments, when the fact becomes more and more evident that the traffic upon our roads is no longer local and intermittent, but national and constant, unrestricted by distance, time, or season, thus making it essential that national funds be allocated to the uniform maintenance of important highways, whether traversing thinly populated and poor districts, where an expenditure of say, 100*l.* per mile means a 1*s.* rate, or those in crowded and wealthy areas, where a similar expenditure represents but a 1*d.* rate.

It is a matter of satisfaction and congratulation that the Engineering Consultative Committee of the Board is composed of prominent members of this Institution, whose technical knowledge and experience are of the highest and command the confidence of our profession.

The Third International Road Congress takes place in London next year, when I trust the members of the Institution will be largely represented and assist in making the congress the most successful and beneficial yet held. The past few years have

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witnessed an exceptional advance in the practice of road construction and maintenance in this country, including the provision of mechanical appliances of the greatest utility, and unquestionably there is a mass of valuable information available if our members take their part in providing the congress committees now at work with the results of their investigations and practice.

I trust therefore that members who have not yet contributed the results of their experience will, at an early date, communicate with the honorary secretary of the congress or any members of the Institution acting upon its various committees, by whom such information will be duly considered and incorporated in the reports to be submitted to the congress, as representing the opinion of road engineers of this country.

The inconsistencies and anomalies in the Highways Acts, the Motor Act, and the Heavy Motor Car Order, relative to weights permitted upon roads, licenses payable, etc., are daily becoming more apparent, and further efforts should be made to secure their amendment and simplification, not only in the interests of road authorities, but also of owners of some classes of self-propelled vehicles, now seriously handicapped in the keen struggle for existence.

Progress has been made in this direction by the Institution in calling the attention of the Local Government Board and the County Councils Association to these urgently required amendments, and I am strongly of opinion that the Institution should continue its efforts to secure early adjustment of these important variations, which are now responsible for needlessly heavy injury to roads maintainable by authorities already severely handicapped by the rapidly increasing expenditure due to the growth of general traffic. The introduction of the trackless trolley system between Leeds and Bradford is a new departure in this country which will be closely watched, as the possibilities it opens out, if successful, are considerable. The question of contribution to road upkeep by the owners of these vehicles is one that will merit consideration.

The Duties of Municipal Engineers.

Recent additions to the municipal engineer's duties include those imposed by the Housing and Town Planning Act, and much progress has already been made in the difficult task of

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providing habitations for residents of the poorer class whose present abodes are required for widening or new street construction in congested parts of great towns; also in laying out and developing entirely new towns or colonies in rural surroundings; but in the latter case it is not certain that all recent enterprises have improved upon the ordinary suburban road or house, either in general arrangement, quality of work, or general effect. The adjustment of artistic aspirations to the essential requirements of modern by-laws is often difficult, sometimes impossible.

The duties and responsibilities of the Local Government engineer are ever increasing, the requirements of the public become more exacting, and the area of municipal work is constantly extended. It requires, therefore, ceaseless activity on our part to be abreast of the times and to make ourselves conversant with all recent developments in our profession, so that our authorities can, with every assurance, rely upon their officers when work of such a character is contemplated.

In the preparation necessary for this contingency our Institution has a record of excellent service, the numerous visits paid to towns throughout the country having enabled members to inspect works of the latest and most modern types of which their designers have unreservedly afforded complete and minute descriptions.

That this practice will continue and develop I have not the least doubt, and its existence will add to the usefulness and power of this institution.

Local Authorities' Expenditure.

The increase in the expenditure of local authorities continues as new duties and responsibilities are placed upon them by the inevitable demands of a higher civilisation, and it is a matter of vital importance that the liabilities of the present and future ratepayer be fully considered and equitably adjusted.

The growth in expenditure defrayed by loan has been phenomenal, and the proportion of present-day rates required to meet these charges is rapidly increasing.

It is a matter worthy of serious examination whether the ease with which loans can be resorted to is not at times responsible for expenditure not entirely necessary and upon work of limited durability.

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Consideration is desirable to the probabilities of future developments and discoveries superseding much of our modern practice, so making useless many undertakings upon which the loan charges have still to be paid, and which would in such cases be a burden upon our successors, who would presumably have, in addition, the responsibilities of their generation to meet.

The Institution Orphan Fund.

No annual address is complete unless reference be made to our voluntary organisation for the relief of our helpless little orphans. Instituted by one of our most esteemed past-presidents, whose labour of love must assuredly be accounted not the least of his life's good works, this fund has accomplished much already in providing for and educating little ones made orphans by the decease of the breadwinner; and the information laid before the committee in these cases is of such a heart-rending character that it has been a matter of extreme difficulty in many instances to afford relief in any degree adequate to the requirements.

Need I repeat that additional subscribers will be welcomed, however divergent the amounts they find it practicable to contribute, and that the entire income of the fund, less postages, is actually expended in direct relief to children of deceased members whom many of us have known, admired, and mourned.

Conclusion.

In conclusion, may I be allowed to thank you for placing me in this proud position, an honour which I prize more than words can express?

To profit by the example of many illustrious men who have occupied this chair is my ambition. To equal their achievements is impossible; but with the assistance of the council and officials, and your generous forbearance, I will endeavour to discharge the duties pertaining to my position with the whole-hearted desire to encourage our younger members, to promote the best interests of all, and to increase the usefulness and prestige of our Institution.

Votes of thanks were passed to the President for his address, and to Mr. A. D. Greatorex for his services as President during the year.

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MASONRY RESERVOIR DAMS: A SIMPLE FORMULA FOR THEIR DESIGN.

By F. C. UREN (*Member*), Surveyor U.D.C. Aldershot.

The Author has chosen this subject more on account of its intrinsic interest than its novelty, for while a good deal has already been written on the subject and a number of exhaustive and interesting papers have been submitted from time to time, yet as our experience increases in the design of such structures, we find the subject still retaining its absorbing hold alike upon the academical and the practical engineer.

Every failure gives the mathematician fresh opportunity for further investigation and the propounding of additional theories. The recent disaster at Austin, Pa., is a case in point, and we have as many as four fresh brochures in less than a month as a consequence.

Both the theorist and the practical engineer have their proper place in the design and execution of these important works. Before the practice of the latter can, however, be utilised, it is essential that we should have some framework to base our design upon; so that the solution of the problem must rest in the first place with the mathematician. Then the work of practical men would dictate such alterations as previous experience and the circumstances of the case may suggest.

The result is a typical design which practical experience accommodates to any given set of variations from the premises in the typical case.

So far as the mathematical side of the question is concerned, however, the Author ventures to suggest that engineering is a little overdone with very complicated and elaborate formulæ, and in the course of this Paper he will endeavour to show that intricate calculations for the design of masonry dams are unnecessary.

To the French engineers, Messrs. Sazilly, Graeffe and Delocre,

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is due the honour of having first discovered the exact method of designing the typical dam. Prior to their investigations, the factors which influenced the dimensions of large dams were somewhat imperfectly known, and all those which had been built were trapezoidal in section. They had been designed to fulfil the condition that their moment of resistance to overturning should be two, three, or four times the resultant moment of the forces tending to overturn them. For a dam to overturn, however, the resultant pressure at the face would have to pass through the edge of the base, and, long before that pressure

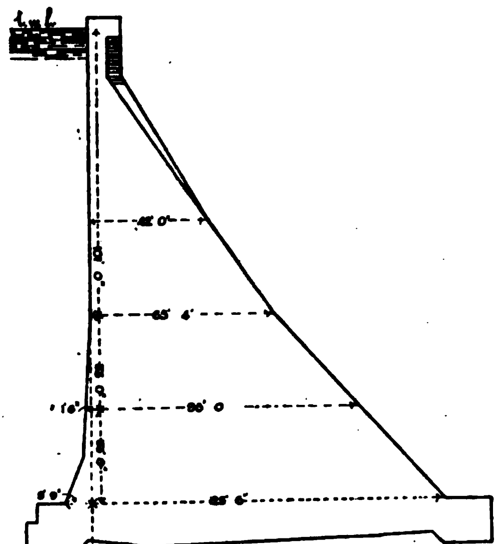

Fig 1
Chartrain Dam

could reach that point, the toe of the dam would begin to crush; and in many cases (notably those in Spain) the dams were crushed by the enormous weight of masonry injudiciously placed.

The theory of Graeffe and Delocre was merely the application of mechanical principles to determine a form of dam in which the crushing pressure should not exceed proper limits on the down stream face when the reservoir was full, and on the up stream face when the reservoir was empty.

Their methods of calculation, while extremely laborious and involving incidentally such exercises as the solution of equations

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of the sixth degree, led to a form of dam more economical of material than the trapezoidal form previously adopted, that required indeed but one half of the masonry. To prove that they did not merely deal with theory they erected from the formulæ they expounded several dams which quite startled the engineering world by their boldness; among them were the well-known dams of Ban, Chartrain, De la Terrasse, and the Furens; the latter of which the Author saw in 1909 in the Gouffre d'Enfer, near St. Etienne. Compared with the Gileppe dam, near Vervier, which had a section two and a half times as large

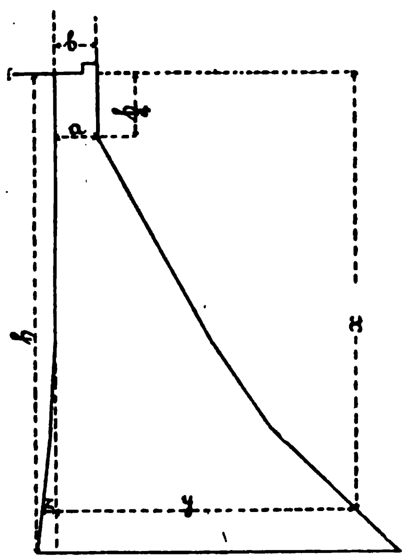

Fig 2.

as it need have had, it was remarkably watertight. There was no leakage on the outside, although the dam had to sustain a head of water 150 feet high.

Following Sazilly and Delocre came Sir Guildford Molesworth, who undertook to devise some simpler formulæ which would give an approximation to the results of the French engineers. His formula, which is of great value, gives results in accordance with that important condition laid down by eminent mathematicians and engineers as essential in all structures of this kind—that there should be no tension in the

dam—and this law necessitates the resultant pressure reservoir full and empty falling within the middle third of the section.

The formula is now well known and is:—

H = height of dam in feet.
x = any depth below surface of water in feet.
y = offset from vertical line to outer face in feet = $0{\cdot}6x$ as a minimum.
z = offset from vertical line to inner face in feet.
b = width of dam at top in feet.
a = width of dam at $\frac{1}{4}$H from top in feet.
P = limit of pressure on masonry in tons per sq. ft.

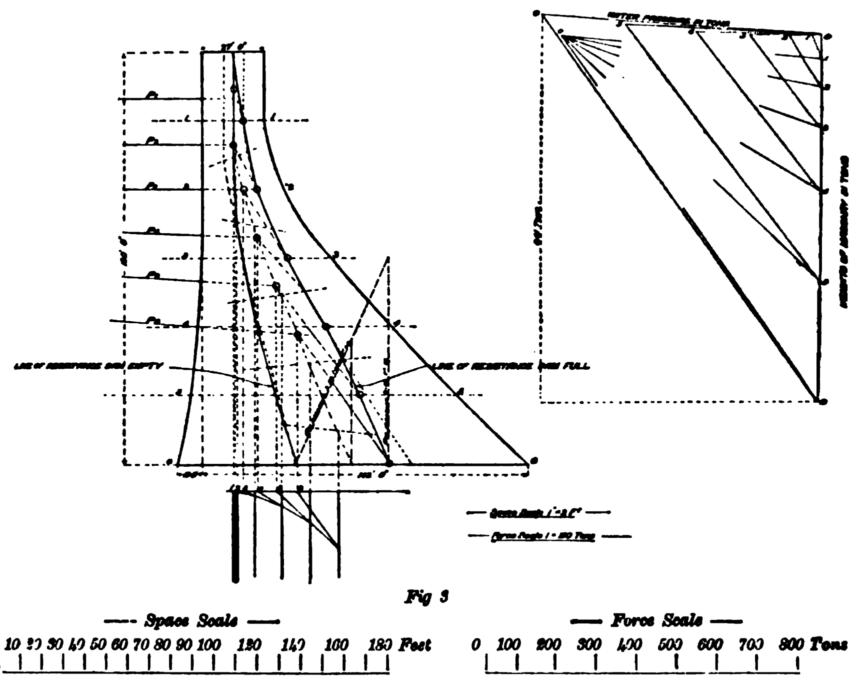

Fig 3

If y as given by the formula be less than $0{\cdot}6x$, it must be increased to $0{\cdot}6x$.

$$y = \sqrt{\frac{0{\cdot}05x^3}{P + (0{\cdot}03x)}}\,;\ z = \left(\frac{0{\cdot}09x}{P}\right)^4$$

Assuming the case of a dam 180 feet high, and divided by

four imaginary planes, built of masonry weighing 145·6 lbs. per cubic foot, and with a permissible limit of stress equal to 20,000 lbs. per square foot, the section obtained by graphic statics is shown in Fig. 2. Whether full or empty it will be seen that the resultant falls well within the middle third of the thickness of the dam at each place.

Since Messrs. Graeffe and Delocre investigated the problem, at least thirty high masonry dams have been built, and amongst those there were only two, as far as the Author knows, in which Molesworth's form was widely departed from. The first of

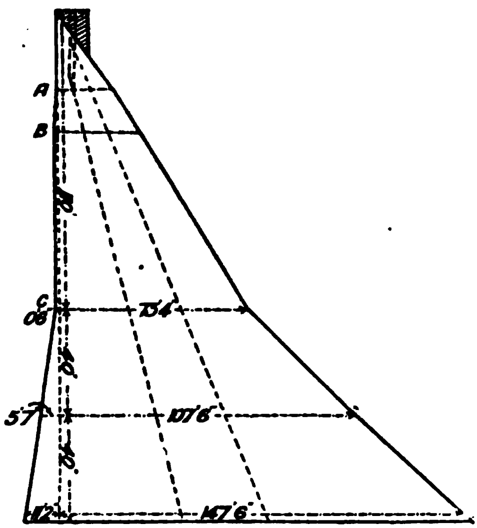

Fig 4

these was the Gileppe dam already mentioned, which had a section at least two and a half times as large as it need have had; the other was the well-known Vyrnwy dam which also had a section considerably greater than a purely rational section.

Another excellent formula that does not involve high mathematics which should appeal to engineers is that propounded by Dr. Brightmore:—

$$b = \sqrt{\frac{wh^3}{s}\left(1 + \frac{w^2h^4}{4W^2}\right)}$$

where

b is the breadth at a depth h below the crest;

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W is the weight of masonry above b, and of the water over the inner face;

w is the weight of unit volume of water; and s is the maximum stress allowable in the dam.

"This formula gives the breadth at any depth in terms of that depth, and of W. At first sight it would appear that the presence of the latter factor would render the formula useless; but examination shows that the term containing W is small compared with the first term in the formula; in fact it ranges from $\frac{1}{6}$ to $\frac{1}{8}$ of the whole expression between the depths 110 and 190 feet; so that if W is known even approximately, the breadth can be readily and accurately found. Thus the tentative part is thrown into a factor of minor effect; by considering successive laminæ the breadths are simply calculated; and by taking moments about the inner third of the breadth, the projection at the inner face is deduced without either finding the centre of gravity of the dam, or of the water over its inner face. The method of calculation, it will be seen from the diagram, applies, with the data given, to a dam up to 190 feet high."

The conditions upon which the above solution is based are:—

(*a*) A maximum compressive stress on any plane not exceeding in intensity from 6 to 12 tons per square foot.

(*b*) Absence of tension at any point.

(*c*) A greater resistance to shearing than the total horizontal thrust of water.

When the Author first wrote upon this subject (see "Transactions Institution of Civil Engineers," Dublin, vol. xxxvi.) he was somewhat sceptical about the necessity for the resultant falling within the middle third, and consequently was far from fixing the condition that there should be no tension anywhere at the faces of the dam.

Any considerable deviation of the line of pressure, reservoir full, from the middle third was undoubtedly a danger, but a slight departure, he thought, would not be inconsistent with good practice, for Rankine had only said "that the line of resistance should be within but a small distance beyond the middle third of the wall."

At that time he preferred the formulæ prepared by the late Colonel Pennycuick, C.S.I., R.E., who designed and erected the

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great Periyar dam—the highest masonry dam yet constructed. His formulæ are appended.

In Fig. 5,

$$y = 0{\cdot}97\sqrt{\frac{x\{x^2 + \frac{7}{4}d(x - d)\}}{p}}$$

p being the limit of pressure in *feet of water*; or

$$y = 7{\cdot}67\sqrt{\frac{x\{x^2 + \frac{7}{4}d(x - d)\}}{p}}$$

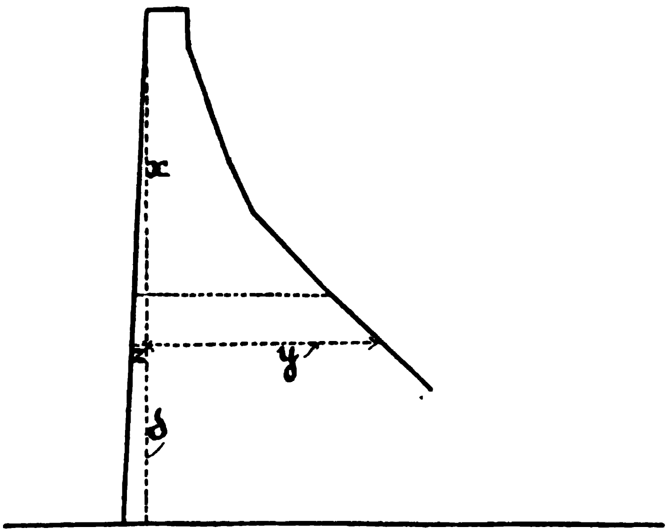

Fig 5

p being in *pounds on the square foot.*

If d be greater than $\frac{x}{2}$, $\frac{x}{2}$ should be substituted for it in the formula, which then becomes

$$y = 1{\cdot}17\sqrt{\frac{x^3}{p}}$$

or

$$y = 9{\cdot}25\sqrt{\frac{x^3}{p}}$$

according as p is in feet of water or in pounds on the square foot.

It is not easy to give a satisfactory formula for the value of

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z based upon the limit of pressure to be allowed, as it is not until a depth of 120 feet that any limit likely to be adopted in practice comes into play at all.

Molesworth's formula $z = \frac{1}{10}y$ gives an unnecessary amount of material at depths of 150 feet and under. A vertical face for the first 40 feet; a slope of 1 in 20 for the next 40 feet; 1 in 10 for the third, and so on; increasing one-twentieth at every 40 feet, gives satisfactory results within all practical limits.

Later experience and consideration, however, have convinced the Author that the real danger of failure in a dam built of

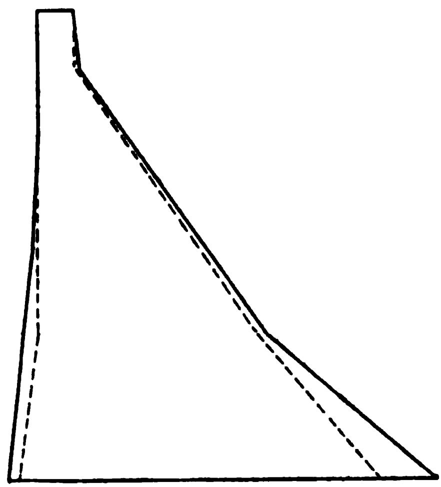

Fig 6

The Author's Design ————————

Dr Brightmore's Section - - - - - - - - -

proper materials on a suitable foundation does not lie in the danger of crushing of the materials (the resistance of which is far greater than had been supposed), but in that of percolation or shearing, and that the dimensions sufficient to guard against these two dangers will amply suffice to meet that of crushing; so that elaborate calculations of the resistance to the latter are waste of labour.

If the following simple rules are observed by those designing a masonry dam nothing more is really needed, for they will be found to give results so nearly accurate that they may be adopted without risk of error:—

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(1) Under no circumstances whatever should there be any risk of tension on either face.

(2) That the total area of the section at any depth x should not be less than $\frac{x^2}{3}$; of course, for convenience of construction and resistance to shocks, it must not be much more than this in the upper part.

(3) That $y = \frac{7}{10}x$ down to 100 feet in depth; and over 100 feet $y = \frac{1}{15} \times x^{\frac{3}{2}}$.

(4) z to be calculated as already mentioned, i.e. a vertical

Fig 7

The Author's Design ————————

Molesworth's Section - - - - - - - - - - - -

face from 0 to 40; 1 in 20 from 40 to 80; 1 in 10 from 80 to 120. $\frac{x}{20}$ from 120, 160, and so on.

Comparisons between the results obtained from the other formulæ given in the Paper, and the very simple one advocated in rule 3 above may be seen upon reference to the accompanying diagrams, Figs. 6, 7, and 8, for dams 160 feet in height.

Masonry dams are, of course, very costly as compared with earth embankments—where the latter would cost 100,000*l.*, that of a similar dam in masonry would be about 250,000*l.*—but

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they are indispensable where risk of failure must be avoided at all costs. Probably the attention of engineers in designing dams in cases where economy is a matter of prime importance, will be more and more directed to those which are curved in plan. Many such have been built of recent years, especially in New South Wales, where considerable economy of cross-section has been obtained by horizontal curvature. In these cases, however, the whole dam has been on one curve, with its abut-

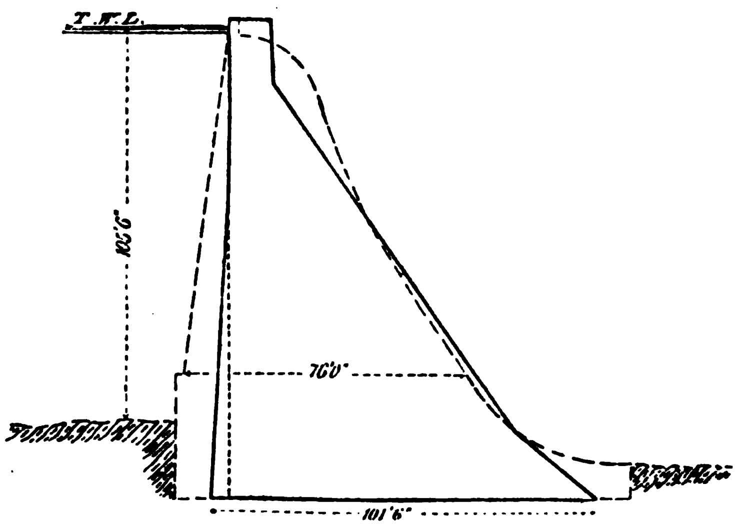

Fig. 8

The Author's Design ————————

Mr. Mansergh's Design for the Elan Dam Birmingham Corporation Waterworks - - - - - - - - - -

ments secured in the rocky sides of the gorge or valley where the water is impounded. Another and very interesting form of construction is that advocated and carried out with success, by Captain A. H. Garrett, R.E., and also (independently) by M. Gaudard, of Lausanne, where the dam consists of a series of horizontal arches abutting against horizontal piers, long enough and strong enough to resist water pressure. This form of design may be said to represent the last word, so far, that science has

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had to say on the subject, though the application of reinforced concrete may possibly introduce still greater economy. Dams of this nature have been constructed in other countries, but all the reinforced dams constructed up to the present—of which the highest the Author could find was 65 feet—had been, so far as he was aware, for power purposes, and not for waterworks.

DISCUSSION.

MR. A. P. I. COTTERELL: The subject treated, although useful, is somewhat academical, as there may not be many in this room who will be called upon to design dams. The Author considers various formulæ used in the designing of dams, and boils them down into four simple rules, but I think that he will be the first to admit that this is not all that is necessary in designing masonry dams, and that one must have regard to particular conditions of construction, not very clearly alluded to in the paper, which may very easily upset the results obtained by some of these rules. There are such things as the character of the foundations, the material available, the site, involving the danger that might attend some forms of construction due to buildings or villages being situated immediately below the dam—such for instance, as we have in the case of the Howden dam in the Derwent Valley, which has one of the residences of the Duke of Norfolk below it. Also there is the question of trouble from flood water. All these things may make some difference in the design, apart from the rules, and determine whether to use an earth embankment or a masonry dam, or in the latter case, the kind of masonry dam to adopt. Then it is not possible to say that there never shall be any tension in masonry dams. Just consider the case of a somewhat yielding foundation; this will set up stresses which the mathematical designer cannot foresee. Or again, if the soil on which the base is founded is different in character in one place from what it is in another, soft, say in one part, and rocky in another, stresses are set up in such a case which are quite outside the Author's calculations. The late Sir Benjamin Baker, a great authority on masonry dams, talked of them as "elastic solids," implying that changes might go on apart from the mass moving. He got out a jelly model by means of which he showed how slight changes might take place in the structure, and he also held that we

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must design not only for much heavier compressive stresses, even up to fifty tons to the square foot, but also be ready for a tensile stress of ten tons per square foot. At the Croton dam the pressure runs up to 14 or 15 tons to the square foot. Looking through these four simple rules, I have just dealt with Rule I. Rule II. seems to be included in Rule III., which looks very like a rule you will find in any old edition of Molesworth come to light again. As to curved dams, they are undoubtedly a good arrangement, though we must remember that there is a limiting radius to a curved dam. When it gets beyond a radius of 400 feet the curve becomes ineffective, and a curved dam is then to all intents and purposes the same as a straight one. Australia has a number of instances of curved dams that look extraordinarily thin in section. As to the suggestion of horizontal arches with deep piers, that is a direction in which progress can be made, but it is not new. The idea has long been used for retaining walls. A former President of this Institution designed a retaining wall on these lines, to keep back a slip on a hillside in Bristol, and it has been very effective. The hollows behind were made use of as cellars, while the curtain wall was pierced for windows. With regard to reinforced concrete, there is little doubt that this material can and will be utilised more and more for the construction of dams. It possesses distinct advantages in its ability to take strong tensile stresses. It is clear that the constant progress and development such as we see evidenced in the extending use of reinforced concrete will bring about still further changes in the design of dams. The subject is an enticing one, and my hope is that any here who may be called to enter the field may be sufficiently discreet in their efforts as to command success.

Mr. Elford: I have much pleasure in moving a vote of thanks to Mr. Uren. It may not fall to the lot of any of our members to design dams of the kind referred to, but notwithstanding this, a paper of this kind in our "Proceedings" must be useful for reference, especially as the principles of design observed in a dam of the kind described will apply more or less to other structures of a similar character. I suggest, however, that Rule I. would not be applicable to concrete structures. In reinforced concrete work it is usual to allow twenty or thirty pounds for the tensile strength of the concrete. I have recently been carrying out some important works, and samples of the

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concrete have been taken from the bunkers at frequent intervals, and made up into test bars. Only in one instance has a sample broken at a lower tensile stress than 200 lbs. per square inch of sectional area, after eight weeks. I think that shows that we should not entirely ignore this very valuable quality of the concrete.

MR. J. JULIAN: I second the vote of thanks. The subject is one of great interest, but in practice possibly it would be found that one could afford the time to go into it without the use of simplified formulæ. In Rule III., I think it would be desirable to substitute 110 feet in depth for 100 feet. At present the rule would give a less thickness for a dam 101 feet high than for one 99 feet high. Actually the limiting depth for the straight line formula depends on the pressure allowed.

THE PRESIDENT: One has to exercise especial care in designs of this character, bearing in mind the terrible results which are liable to accrue in case of failure. We have instances in American practice, as you all know. In English practice we shall no doubt all exercise our national caution, and our error, if there be any error at all, will be on the safe side.

MR. UREN, in reply to the vote of thanks, said: I appreciate very highly the kind reception accorded to my contribution to the "Proceedings." As this is my first appearance in a *rôle* of this character, I naturally felt considerable diffidence in submittting my theories to so many eminent practical men. It is true these theories are based upon considerable personal observation, but it is one thing to hold theories, and quite another to flaunt them before a critical engineering society. With regard to Mr. Cotterell's remarks, I am aware of the circumstances which still should have been noticed in order to arrive at a complete solution of the problem, but I am sure that it would be of no further practical advantage to enter into too minute details, and, on the other hand, I think any expansion of the theory might be arrived at without any difficulty. My intention is to urge that the design of a structure consisted chiefly in determining its form and dimensions. That problem, however, would not be satisfactorily solved empirically, but only by the aid of scientific investigation, but I have satisfied myself that the formula I have presented does provide for the points he has raised. It provides, among other things, for ordinary defects of workmanship, the varying quality of stone and cement, and

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something for differences of temperature arising out of the construction of such massive works all the year round. I think I may claim that the formula is simple, and in cases where the safety of property and life is involved, as is generally the case in valleys below high dams, all the points Mr. Cotterell has named should be provided for. I submit that a formula which provides for no tension whatever in the dam covers these points. Mr. Elford takes up a position which is practically that which I took when I first wrote on the subject, viz. that there should be some allowance for tension in all concrete work. To-day I take a different standpoint. I say the formula should be such as to allow for no tension at all in a masonry dam. If we err at all we should err on the safe side in important works of this character. With regard to Mr. Julian's remarks, there is a misprint in Rule III., the word "up" should be "down." I am glad that Mr. Julian called my attention to this because I know how keen he is on the mathematical side of constructional work. I should like to say, in conclusion, how desirable it is there should be a standard system of symbolical notation. One engineer employs x for a dimension, and another employs z, yet another y. The result is endless confusion and considerable waste of time is involved.

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BACTERIA.

By WILLIAM RANSOM, Assoc.M.Inst.C.E. (*Member*),
Assistant City Surveyor, Worcester.

The popular conception of the subject of bacteria is not very inspiring, for it is usually sufficient to mention the word microbe, germ, or micro-organism to bring in imagination before the minds of most people hideous and awful creatures with creepy slimy legs, and repulsive and ferocious features lying in wait to injure poor humanity in his food, drink, and air. Water and sewage engineers, however, know how much they owe to the bacterial work, and that bacteria play a very important part in the dispensation of nature, and are as much the allies as the enemies of mankind.

If we take a microscopic tour we shall find that the Lilliputian world which is revealed to us is one full of romance and excitement, and that its myriads of inhabitants are gifted with powerful means for good or evil, as great or greater than any other agency in the universe. We must first clearly understand that our travels will be undertaken, not in the animal world, but in the plant world. The organisms called bacteria comprise a class of low plants, and for a long time the importance of their place in Nature was not recognised. They were simply a subdivision of one of the lowest forms of life, but as the study of their life history became specialised, and bacteriology became a science, it was soon evident that this sub-division of the plant world was of greater importance than the rest of the division. The word "microbe" has been adopted to signify all microscopic plants commonly included under the term bacteria and yeast. The Author confines this Paper to the former class, of which single specimens are known by the name of bacterium.

The study of bacteria commenced with the advent of the microscope, and as that instrument improved, so our knowledge of the bacteria world developed into an exact science.

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It was a Dutchman named Leeuwenhock, born in 1632, who first demonstrated the existence of micro-organic life. He discovered living organisms in water which he called animalcules. The next man to advance the subject was Plenciz of Vienna, who about 1750 first conceived the idea that decomposition was due to the above animalcules. Scientists were gradually coming to this opinion when Liebeg checked advancement by advocating that decomposition and putrefaction were simply chemical actions. For a considerable period the theory of spontaneous generation was held, except by here and there some scientific worker investigating upon the right lines was yet unable to bring his facts in a sufficiently convincing form before the world. It was Pasteur who really rescued bacteria from obscurity and gave them their right place in the scientific world. The story of his experiments and researches is a romance, and gradually he accumulated such an irresistible array of evidence that he was able to give the death blow to the theory of spontaneous generation. His experiments demonstrated beyond doubt that fermentation, putrefaction, and infectious diseases were all due to micro-organism. Koch and others followed up the investigations and a new science was opened to the world, with results as far reaching as any other branch of knowledge.

The microscopic world is densely populated, for upon one square inch it would be possible to find a population one hundred times as dense as that of London. There are all sorts and conditions of bacteria, but they can be described as minute specks or cells of protoplasm which usually take one of the following shapes:—

1, Round cell form, or the coccus.
2, Rod " " " bacillus.
3, Thread " " " spirillum.

The cocci consist of groups of round cells less than $\frac{1}{25000}$ inch in diameter, and appear in different forms either in single bodies or in groups of one, two, three, etc., and often having the appearance of a string of beads.

The bacilli consist of cells longer than they are broad. Many of these varieties are gifted with powers of motion.

The spirilla consist of wavy threads attached to a round or rod-like cell.

These varieties of microbes are the simplest forms of life

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that are known to science, and are to be distinguished from the yeasts and molds which have a more complex life history.

The bacteria have a short but active existence, but they reproduce themselves in great numbers by budding, division and spore formation. The latter method of reproduction is one adopted to ensure the preservation of species, in case the other methods should fail. The spores, or seeds, are formed inside the rods or spiral forms, consisting of a tiny bit of protoplasm. The bacterium producing the spore usually dies, but it leaves behind the hardiest form of living matter known to science. Spores can survive hunger and thirst, the perils of an Arctic winter, and some even the dangers of boiling water. These spores naturally increase the difficulty of disinfection, for means which would speedily kill off all bacteria may be unable to touch the spore, which Phœnix-like spring into life from the ashes of ordinary methods of disinfection.

Bacteria have a wonderful power of multiplication. If favourable conditions could arise one bacterium would produce in one day over 16,000,000 descendants, and in two days over 281,500,000,000, which it has been calculated would form about one pint, and weigh about one pound. Fortunately for this densely populated world favourable conditions for such a growth do not occur for an extended period, for reproduction is speedily checked by want of food, and also by the fact that bacteria are quickly killed off by the products generated by their own existence. The wonderful power of growth in bacteria is due to the food which they can assimilate, for they can feed on a complex diet made up of organic substances all ready for absorption. Most plants have to obtain their food from simple substances such as CO_2 and H_2O. As bacteria can live on the food which they find ready manufactured for use, their growth and multiplication is simply limited by their power of absorption, until the chemical changes produced in the food itself by the life of the bacteria checks the growth and affects the food substances.

One of the nearest bacterial relatives in the plant world is the green plant called oscillaria. The green colouring matter called chlorophyll is, of course, absent in the bacteria, and it has been surmised that it is the absence of this matter which forces the bacteria to find new and unorthodox methods of food supply.

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The means taken for the examination and identification of bacteria are complex. The broad principle consists of sterilisation and cultivation. Supposing, for instance, a liquid has to be bacterially examined, the first thing to be done is to sterilise all instruments and appliances which will be used during the examination. This is done by various means, such as heat, filtration, etc., so as to kill off all bacterial life to enable the examination to be made without fear of any outside bacteria being introduced into the sample. Every care has to be taken to prevent air obtaining access to the sample which might thus be contaminated with foreign bacteria. When sterilisation is complete a few drops of the sample liquid are applied to a culture medium in sterilised surroundings. The medium consists of some suitable food material, such as gelatine, upon which the bacteria present in the sample may thrive and develop. After a little time the naked eye will reveal on the gelatine plate little specks, each centre being in reality a colony or pure cultivation of one particular organism. Each little speck can be transferred to a separate culture medium so that a pure cultivation can be developed and undergo a thorough investigation. The method adopted for counting the number of specimens in any known quantity is comparatively simple. A small measured portion of the liquid is applied to the culture gelatine, and the bacteria allowed to develop. After a certain time the specks or colonies are counted, and as each speck or colony has come from one germ or spore the number of bacteria in the quantity under examination is thus ascertained. The real difficulty is, of course, in discriminating the individual germ from a group of bacteria. One of the many methods adopted for the identification of bacteria is that of staining the microbes under examination. Some are particularly partial to special dyes, while some spores will not be stained by a weak solution. A liquid under examination would be divided into several portions, and dyes of varying strengths and colour applied, and as a result different kinds of bacteria would be stained to various colours. Results, however, are very difficult to standardise, for bacteria are so easily influenced by the food they live upon, and in the same family it is most difficult to establish the relationships between the rich and the poor, the fat and the lean! Bacteria very quickly deteriorate under some circumstances, and weakened specimens appear to possess characteristics

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altogether different from their more robust brethren. The difficulties of identification are therefore very many, and we have often to be content with judging our secret friends and foes by their actions rather than by their names. Dr. Houston has told us how the typhoid bacilli quickly deteriorated in raw Thames water, and that he had drank 218,000,000 attenuated typhoid germs without any ill effect.

The purification of river-water for public purposes chiefly consists in the removal of the majority of the bacteria. The work done by sand filtration is estimated by the percentage of bacteria removed, so that the bacterial examination of water is of great importance to the water engineer. The gelatinous micro-organic tissue which gradually forms on the top of the sand filters acts as a bacterial screen, or as a sort of cultivation medium which retains the majority of bacteria from passing through the filter. The perpetual flow of the water must carry away with it those products of bacterial life which would otherwise automatically prevent the growth of the gelatinous scum. Whatever these products may be, they do not have a deleterious effect upon the water. Filters occasionally get out of working order, and perhaps it may be due to a partial period of suspended bacterial action, because the products of bacterial life are not being carried away sufficiently fast.

In recent months a great deal of discussion has arisen as to the significance of bacillus coli in drinking water. Mr. J. R. Johnstone in the publication of the United States of America Department of Agriculture has been recording some remarkable experiments and investigations. He has experimented with bacillus coli, and has found that healthy cocoa-nut trees when inoculated with it are attacked with the bud rot disease, while organisms cultivated from diseased trees behave exactly as the bacillus coli. This opens up a large question to water engineers, as the bacillus coli has been looked upon rather as a danger-signal than as an active source of disease.

Bacteria are to be found almost everywhere. They are present in the soil to a depth of three to four feet, in water, and in the air. They are most plentiful wherever decay is going on, because of the abundance of food supply thereby provided. While bacteria do not occur in the tissues of the living healthy body, they attach themselves very readily to the surface of the body.

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The effect of sunlight upon bacteria is very marked. A striking but simple experiment consists in making a "micrograph." Some known bacteria—say typhoid germs—are placed on gelatine and exposed to sunlight, but with the word "Typhoid" cut in cardboard letters placed on the top. The cardboard excludes the sun over a certain portion, and it is found that the bacteria which are exposed to direct sunlight cannot develop. The bacteria under the covered portion multiply, and as they develop print their name "Typhoid" on the gelatine plate.

It must be remembered that bacteria are not always active. They are often dormant, as, for instance, in water which contains no food, and, again, when present as dry dust in the atmosphere. The two great things which are needed are food and moisture, and, given these, their powers of multiplication are soon developed. Nature has largely restricted them to scavenging duties, and allows them comparatively free scope only so far as it relates to the bodies, whether of animals or of plants.

The effect of bacterial life is seen all around us. As the bacteria feed, so they produce chemical changes which alter the face of nature. Whatever work is done the bacteria give rise to numerous products which affect the original food stuff. Briefly, the products, which are called ptomaines, are:—

1. Pigments (as a rule produced by innocent microbes).
2. Gas, such as H, CO_2, CH_4.
3. Acids, such as lactic, acetic, butyric, etc.
4. Liquifying ferment.
5. Phosphorescence (as evidenced in the glow produced in sea-water by myriads of animalculæ).
6. Organic chemical products.

Bacteria are directly engaged in many industries influencing the flavour of various productions. Some of the dangerous forms of bacteria have to be guarded against to avoid their work of harmful decomposition. Many industries have been inaugurated to circumvent the decomposing bacteria, such as the building of ice-houses, salting fish, smoking hams, canning fruit, etc.

A large army of bacterial workers are told off to do the scavenging work of the world. Bacteria believe in the utilisation of all matter, and do not allow the resources of Nature to

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be wasted. By this means the ground is prevented from becoming unfertile. They seize upon anything that is dead and doing no work, and convert it into suitable material for the life of plants.

Mr. Conn has prepared an interesting diagram illustrating Nature's food cycle and the part played therein by bacteria. Plants in the first case obtain their food (CO_2) from the air and water (H_2O) and another portion from the soil (nitrates). Plants by means of the sun's heat build these into complex matters such as sugar, starches, fats, and proteids. These products form food for the animal world and help to build up the animal bodies. When they die the organic matter would not support plant life. The decomposing bacteria readily seize hold of the dead bodies, and break down the complex matter into simpler matters such as CO_2, water, etc., which are available life, or into ammonia and nitrogenous compounds such as nitrites which are not capable of being absorbed by plants. To reduce these nitrites into nitrates and then complete the food cycle, another form of bacteria are brought into operation. These are called nitrifying bacteria, and have the power of adding oxygen to the nitrites, thus converting them into nitrates which can be absorbed by plants.

During putrefaction a small portion of nitrogen is dissipated into the atmosphere, and for a long time scientists wondered how the soil was able to recover this lost nitrogen. If it were not recovered the soil must gradually get less fertile. It has been found that there are some forms of bacteria which have the power of abstracting nitrogen from the atmosphere, and thus we see in Nature's scheme of perpetual motion in the food cycle that bacteria play a most important part and enable the soil to retain its fertility.

Everybody now knows how bacteria have been harnessed by Municipal Engineers to carry out in a scientific way the work of sewage disposal. Two classes of bacteria are brought into the municipal service, and artificial conditions are created for their rapid multiplication so that their work can be expeditiously done. The first class of scavengers are known as "anaerobics," and are used to break down and liquify the sewage. As they work without the presence of oxygen, air is excluded by the best artificial means by the provision of tanks. The bacteria would cease action if left too long in their own

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products, and therefore a steady current is usually maintained through the tanks. When the preliminary stage is done the work is handed over to another class of bacteria called "aerobics." These bacteria work with oxygen, and accordingly filters or beds are provided and the air allowed to percolate through the interstices so that the oxygen can be supplied to the bacteria. The work done consists in making the products from the previous process available for plant life.

The possibilities of this method of sewage disposal are being realised more every year. The great problem consists in making the best artificial conditions for the rapid multiplication of the necessary bacteria. The more quickly the bacteria develop the more quickly is the work of sewage disposal carried out. It is very difficult to regulate with scientific accuracy the time which should be alloted to the various processes, and to draw a hard and fast line between the various operations. In Nature the various operations are so dovetailed that it is difficult to know where one process begins and another ends. The sewage engineer is of course working under unnatural conditions, and therefore it is only by experiment that he can find the best means of harnessing bacteria for the work of sewage disposal.

Before concluding the Author must briefly refer to bacterial slumland as represented by such germs as those producing typhoid, diphtheria, smallpox, anthrax, etc. The knowledge of pathogenic or disease bacteria has revolutionised medical science, and the methods of curing many of our diseases consist in overthrowing the particular bacteria associated with the particular disease. The disease germs themselves are not especially offensive to the body, but when they obtain access to the body the bacteria produce poisons called toxins, which are most dangerous to human life. The body appears in a marvellous way to have the power of producing anti-toxins to neutralise or overcome the effect of the toxins. It is the fact which has influenced the modern treatment of disease by endeavouring to impart immunity to the body by inoculation with anti-toxins.

The Author has now completed a very hurried tour of the bacterial world, and has left unexplored many hidden processes and manufactures which have an important bearing on our everyday life. Bacteria influence our health, our food, our drink,

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and almost everything we need. They are the scavengers of the universe, the fertilisers of the soil, the breeders of disease, the manufacturers of flavours and relishes of endless variety, playing an important part in Nature's perfect cycle of endless life and change.

DISCUSSION.

MR. WILLIS: I think every member will agree that Mr. Ransom has put in very readable form the elementary principles underlying the science of bacteriology, and I beg to move a vote of thanks to him. On the question of sewage purification by anærobic organisms, I think further information would be much appreciated if Mr. Ransom could supply some. With regard to sterilisation, it would seem that it does not cover all that at one time it was thought that it would do. Sterilisation is not only what we want: what we actually need is to cultivate and stimulate organisms which are not harmful to the body. We should not, I think, always sterilise milk and other forms of food, as by so doing we do not only eliminate the pathogenic organism which are largely removed from the human system by the phagocytes, but we also remove bacteria which may be beneficent. We should, therefore, endeavour to strengthen the phagocytes, and we shall then tend to keep our bodies healthy. Sterilisation may be the best known treatment at present, but I hope future chemists and scientists will evolve a method of eliminating pathogenic organisms without the removal of those which are not harmful, but are even probably beneficent bacteria.

DR. RIDEAL: I will second the vote of thanks. Sterilisation seems to me to be a very serious problem in connection with water supply and sewage disposal. At Cheltenham the problem is to derive pure drinking water from the Severn, which starts with the bottom and surplus water from the Vyrnwy supply to Liverpool, and later comes down to Worcester, where Mr. Ransom, by putting in bacteria filters is producing an effluent that seems all that can be desired. At Cheltenham we find evidence of these two contributories to the pure Severn water in the bacterial content and in its colour, as these vary from time to time, and the question arises whether Mr. Ransom should not sterilise the effluent in order that people may safely drink the river

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water below his sewage discharge. We can, I think, deal with the peaty black water, but that with bacteria from Worcester is more difficult. The same problem, in a more acute form, arises in London, as most of the members present know within the last few weeks Dr. Houston has proposed the excess lime method of sterilisation. I was out in Singapore a while ago, and there the water supply is derived from a gathering ground at the back of the town where rubber trees grow. The question was discussed whether the rubber trees should be tapped or not, and the corporation was divided into tappers and non-tappers. The point was that if tapping was adopted they would have a number of coolies on the gathering ground, and as a natural result there would be pollution of the water, which was filtered by ordinary sand filters, which the medical officer did not consider would secure sterility. In considering works of sewage disposal we have to consider that it is not necessary for water from such places to be up to the drinking-water standard, and therefore, I think, we should not insist on the Worcester people sterilising their effluent. On the other hand, we have to look at the problem as a whole, and must remember that the people of Cheltenham derive their water from the Severn. That brings me to this point—that we who are interested in this problem should further, as far as we can, the recommendations of the sewage commission, to the effect that the different watersheds should be placed under the control of water boards, which would deal with the water problem as a whole, and would have as members experts on the questions to be dealt with. Attempts in this direction, I may add, have been made more or less successfully in the West Riding of Yorkshire. That, then, is the point that I wish to emphasise and commend to your support; that the result of bacteriological examinations point to the necessity of information on the different watersheds with a view to purifying water to such a bacterial standard that the water shall be useful for the purpose for which it is intended.

Mr. T. Caink: Dr. Rideal has suggested that Worcester should sterilise the effluent before it is discharged into the river, for pending the completion of certain works the sewage has been discharged crude into the river. I was very anxious to ascertain what effect this had upon the condition of the river water at Tewkesbury, where the supply for Cheltenham is taken. Accordingly I had samples of the river water near the Cheltenham

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intake examined and also near the Worcester waterworks intake, which is situated a mile and a half above the sewage discharge into the river, and, to put it shortly, the water taken at Cheltenham works was found to be rather better than that taken at Worcester above where the sewage is discharged into the river.

Mr. E. G. Mawbey: One point that is worth emphasising is the necessity of frequent collection of house refuse. Another is the influence of bacteria in connection with roads and streets. There can be no doubt that, especially in the densely populated districts, excretæ and other foul matters get into the permeable road crust, and thus become breeding places for germs. Therefore there is no doubt that we can do a great deal to preserve the health of towns by attending to the road surfaces, by making them impervious, and keeping them clean. The Author says he thinks the effect of sunlight on bacteria is very marked. Does not that show how very important is the question of town planning; and that it is desirable to have open spaces, and wider thoroughfares, with houses so planned that you get a maximum of sunlight into the rooms? About fourteen years ago I carried out extensive experiments at Leicester in different processes of bacterial and land treatment, and I found then we could get better results so far as the effluent was concerned when we did not carry the septic action very far. I expressed at that time, and particularly in 1900, strong views against advanced septic action, and I find that many are now coming round to the opinion that the extreme septicising of sewage is a mistake.

Mr. G. A. Hart: The perusal of Mr. Ransom's paper has reminded me that as a body we are primarily engineers, and it is hardly to be expected that we should have an intimate know- of the intricacies of the working of bacterial life, and I hold the view that we should be better advised to leave the study and exposition of such a subject to members of the bacteriological profession, and to recognise that our function is to embody their requirements and theories in the works we design and construct in practical form. The Royal Commission on sewage disposal has already given us an indication as to the direction in which we may expect future legislation to be framed in dealing with the purification of sewage, and it would have been a great advantage to most engineers if the requirements upon which sewage works are designed could have been made more adaptive to local conditions. I fear it seems probable that most of our

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local authorities will have been compelled to deal with their problems before any legislation is introduced authorising consideration to be given to local conditions. Some of our larger Municipalities will have been committed to expenditure amounting to something like a million sterling in meeting more or less empirical general requirements, and I think it is to be regretted that it has not been practicable to consolidate standardisation of design based upon authentic records from data in carrying out works of sewage purification in the respective watersheds of the country in such cases. In checking the pollution of our rivers there ought to be a system whereby offenders in the higher reaches of the watersheds should be compelled to remove their contributing pollution before others situated at a lower elevation are called upon to spend money in producing effluents which will be of better quality than the state of the river into which they are discharged. Mr. Ransom has referred to the question of the sterilisation of effluents, and I observe that he states that "the purification of river water for public purposes chiefly consists in the removal of the majority of bacteria." I presume that the Author is referring to water in its pristine condition. If he is referring to water into which sewage effluents have been discharged, and that we are to regard the purification as embracing the removal of all bacteria in river water into which sewage effluents are discharged, then purification in that sense must surely be regarded as being impracticable. It is within the function of an Engineer to determine which is the most effective and practicable means of eliminating pollution, whether by the destruction of bacterial life which may be present in contaminated effluents or by filtration, but I think that we engineers should confine our efforts strictly in the direction of providing the means whereby the theories of the chemist and bacteriologist can be effectively applied.

Mr. Bainbridge: The works I am associated with supply 105 millions of gallons per week, and of this 65 millions of gallons come from a river, and 40 millions from two reservoirs, one behind the other. We take particular care in flood-water time to allow the flood water to go down the eyewash, and collect the clean water: we get the water from a source on the moors, where there are scarcely any houses, and certainly no villages. It is very easy for an expert speaker and clever writer to construct a convincing theory, but to put it into practice is

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not quite so easy. We have spent a very large sum, but we are not in possession of perfection yet. We have no fewer than eleven filter beds, with many settling places, etc., but all that we get out of the water is sediment and colour. Combination of districts has been mentioned. That is what we have done, and it is certain that no poor district could have spent so much. What we should strive for is, by means of combination, to get purity; then you get healthy bodies, and bacteria have not half the power over you then that they have over weaklings.

Mr. W. B. Chancellor: One point has not been touched upon which I think at the same time is of the utmost importance, viz. that engineers should keep to their own department, and when it is necessary call in the chemical expert. I have found in my own practice that the advice analysts have given has been the means of saving considerable expense, and I am sure that if engineers before going into vast sewerage schemes would consult men who have made a life study of bacteriology the results would be more satisfactory. With regard to the sterilisation of effluents, is it not a fact that a good deal of trouble might arise after the discharge of a highly sterilised effluent? I know of a case where such trouble arose, and I have found it to be a fact, that secondary decomposition is more likely to take place in a highly sterilised sewage effluent than in water that has not been so treated.

Mr. T. W. Stainthorpe: I am inclined to favour the view that we engineers have plenty to do in our own profession without taking on ourselves the work of bacteriologists. To begin with, no engineer has the time and the opportunities at his disposal for the work. The proper course is that which I followed when I carried out a large sewage disposal scheme in South Africa. I always worked hand in hand with the Government bacteriologist, and got very good results. I was interested to hear what Mr. Mawbey said about the length of time for tank treatment. South African conditions are different from what you have here, and I found that instead of allowing twenty-four hours for treatment in tank, six hours were sufficient. I do not know how that compares with recent practice here, but I quite see eye to eye with Mr. Mawbey in this matter, and as the years go on I believe that the heavy cost incurred now for building sedimentary tanks will be unnecessary.

The President: I agree with the speakers who have urged

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that it is desirable to have joint water boards. In our own county we have the Thames with its own board in the South, but in the North another watershed without any board or conservancy. The difficulty that arises from dealing with the varying conditions adds enormously to the work of the local authorities concerned, and greatly retards that harmony, and that co-ordination which are most necessary in dealing with this important subject.

MR. RANSOM: I thank all the speakers who have taken part in the discussion on my paper, which is an attempt to deal with a subject bristling with difficulty. I am glad my chief replied so effectively with regard to the operations dealing with the Severn water. Bacteria enter so largely into so many of the engineering problems of to-day, that, without specialising in the subjects, engineers ought to have a knowledge of the life history of bacteria; water and sewage engineering cannot be intelligibly carried out unless the part played by bacteria is fully recognised, although we are far from understanding the full scope of their operations. I thank the members for so kindly receiving my paper, and for the honour in being allowed to read it before this Annual Meeting.

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TOWN PLANNING IN SHEFFIELD.

By C. F. WIKE, M.Inst.C.E. (*Member*), City Engineer and Surveyor, Sheffield.

Town Planning is a subject which has received a considerable amount of attention in Sheffield, both before and since the passing of the Housing and Town Planning Act, 1909. In several instances small areas were dealt with, but owing to the lack of any legislative powers and the unwillingness of the majority of the landowners to co-operate, matters progressed very slowly, until the Act referred to was put into operation, when the Sheffield City Council immediately commenced to take advantage of the provisions contained in the Act. The matter was one which required very careful consideration, and the exercise of the powers of Part II. of the Act was relegated to the Improvement Committee, who appointed a special Town Planning Sub-Committee to deal with the question.

The first step was to decide as to which portion or portions of the city were suitable for town planning schemes. The area of the city is 24,347 acres, and of this about 5000 acres may be taken as being densely populated, and 2500 acres sparsely built upon, or, about 7500 acres which cannot be dealt with under the Town Planning Act. The area not available for building purposes, such as moorland, reservoirs, parks, recreation grounds, precipitous ground, etc., is about 5000 acres, leaving approximately 12,000 acres of land available for further development, and for inclusion in a town planning scheme.

A key plan was prepared showing this land divided into sections, to enable the committee to decide whether they would forthwith include the whole of the undeveloped land available for building purposes in a town planning scheme, or whether they would deal with it in sections. The latter course was considered the most advisable, and three areas were selected as the

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most suitable to be dealt with first, the committee's intention being, as the work in connection with these areas progressed, to take in hand other sections from time to time, until the whole of the undeveloped land in the city is included in a town planning scheme.

The three areas in question are: (1) An area in the south-western portion of the city, containing 488½ acres; (2) an area in the western portion of the city, containing 97 acres; (3) an area in the north-western portion of the city, containing 624¼ acres. A total area of 1209¾ acres.

As no revision of the 25 inches to the mile scale maps has taken place for the last eight or ten years, during which period the development of the city has been very considerable, it became necessary, in order to comply with the Local Government Board's regulations with regard to the preparation of the various maps, to bring the ordnance maps of these areas up to date. The work was at once put in hand, and the new streets constructed, and buildings erected or in course of erection, were posted on the maps, which undertaking involved a great amount of labour. It was also necessary in some instances to spot level and contour the areas, owing to the hilly nature of the land, for the purpose of showing the feasibility and practicability of suggested new main and secondary roads.

The points to which the committee thought it desirable to give their immediate attention in the earlier stages were: The widths of the existing main roads; the lines and widths of new main and secondary roads; the "set-back" of the main building line; the provision of a satisfactory number of open spaces; the limitation of the number of houses to be built to the acre.

The surveyors to the owners of the large Sheffield estates were invited to inspect the plans, and the owners asked to co-operate with the committee in making the town planning schemes a success. Negotiations were opened, and, except in one or two cases, arrangements have been made satisfactory to both parties, the Corporation agreeing to slightly modify their requirements with regard to the number of houses to the acre, set-back, etc., the owners throwing out the necessary land for widening the roads to the widths agreed upon, and the Corporation paying for the street works over the width required by the by-laws, *i.e.* 40 feet. The widths of roads which the committee consider reasonable and which they have decided upon

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CHAS F. WIKE. M. INST. C.E.
CITY ENGINEER & SURVEYOR
SHEFFIELD. APRIL 1911

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are, for existing main roads, 80 feet; secondary roads, 55 feet and 60 feet; and subsidiary streets, 40 feet.

With regard to the limitation of the number of houses to be built to the acre, it was found impracticable to fix a definite "limit" which would be applicable to all the areas, or even to fix a "limit" for the whole of one area, it being considered advisable to vary the number of houses to the acre in different portions of the areas, according to the class of houses in the district, and the density or otherwise of the buildings adjoining, and as to whether it would develop into a working class or residential district.

In portions of some areas, the number of houses to be erected to the acre is to be limited to twelve, these being residential neighbourhoods containing houses of a good class. The houses or cottages already built immediately abutting upon a portion of another area, however, average as many as thirty-five (gross) to the acre, and it would scarcely seem fair or reasonable to fix a "limit" of twelve to the acre for the area adjoining. The Committee, therefore, in order to meet the landowners, have decided to accept a "limit" of twenty-four to the acre for this portion of the area, reducing this number as the area withdraws from the overcrowded district; but this is the extent to which they will be prepared to go in any case, and then only when the owners show a disposition to meet them satisfactorily in other ways.

Speaking generally, it may be taken that for residential and good class districts the number of houses to the acre will be limited to twelve, and in areas adjoining working-class districts twenty to twenty-four.

With respect to the set-backs, the following have been agreed upon: Existing main roads, 15 feet; proposed new main roads, 15 feet; secondary main roads, 15 feet; subsidiary streets, 10 feet; and these set-backs will probably form the basis of agreement when subsequent schemes are taken in hand.

Estimates in connection with these three areas were prepared; these being based on the assumption that the land required for the widenings will be transferred to the Corporation without charge, as has already been arranged in several cases.

The areas were referenced, and the requisite notices to the number of about eight hundred served upon the owners, lessees, and occupiers of the land to be included in the schemes. In this connection it may be stated that the Town Planning

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Department of the Local Government Board was approached, and agreed that the notices need not be served on occupiers with tenancies of three months or less.

The statutory meeting of owners and others interested in town planning was held on September 6 last, the Local Government Board inquiry being held on January 17, 1912. At this inquiry there were present, in addition to the owners and others interested, a number of prominent officials and corporation members from various towns.

There was comparatively little opposition, and this was not to a town planning scheme in itself, but to some details of the draft scheme which the Corporation have submitted to the landowners. The Inspector pointed out, however, that the inquiry was only an initial one to consider whether the preparation of a scheme was desirable, and not to consider the methods by which it should be carried out. The Local Government Board have now given the Corporation permission to proceed with the preparation of their schemes, the details of which will be gone into at a subsequent inquiry. They insisted, however, on built-up portions of districts within, and adjoining the boundaries, being ringed out on the deposited plans, so as not to be included in the scheduled areas.

When the preliminary plans had been prepared and the necessary notices served, and pending application to the Local Government Board, the Committee decided to proceed with two further areas, one in the north-western portion of the city, containing about one thousand three hundred acres, and another in the south-west, containing about one thousand seven hundred and fifty acres adjoining one of the areas already scheduled.

The total area of the Sheffield town planning schemes, therefore, is 4260 acres, which is more than the combined areas of the adjacent towns of Barnsley and Doncaster, and greater than the areas of some towns with populations of approximately a quarter of a million.

The work of posting up the ordnance sheets, and contouring the two additional areas is at present in hand, and it is probable that the arrangements as to widths of roads, number of houses to the acre, set-backs, etc., will be on the same lines as in the case of the first three areas.

An attempt has been made by the Author of a certain paper on town planning, to form a basis of the cost of preparing town

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planning schemes, worked out at so much per acre. It is scarcely possible, however, to adopt a principle of this kind, as so much depends upon the contour of the district. For instance, it is a very different matter to town plan in a flat city or town than in a place like Sheffield, which is of an exceptionally hilly nature with an altitude varying from 100 feet to 1500 feet above sea level, containing five valleys, and where building development gradually extends up the valleys into the country.

In some towns the populated portions are fairly well concentrated, and the town planner has a free hand, but in cases like Sheffield, where the town and country are intermixed, it is very difficult to get good leading lines of communication. The position and construction of main arterial roads must depend upon the levels and contour of the town itself, and at the same time the natural beauties of the suburbs must be preserved as far as possible.

The cost involved in the posting up of ordnance sheets will also vary in different places according to the growth of the town and the date of the last ordnance survey. Sheffield has grown very rapidly since the ordnance sheets were last revised, the population having increased from 376,160 in 1900 to 459,923 in 1912, and, as previously mentioned, the work of posting up has been very considerable.

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TOWN PLANNING: LAYING-OUT NEW TOWNS AND CITIES.

By W. H. PRICE (*Student*),
Sewerage Engineer's Office, Leeds.'

Town Planning played so prominent a part at the last Annual Meeting, that it is only the well-known interest of the Past President and the members generally in the subject that induces the Author to offer still another paper on town planning. The laying-out of a new town or city rarely falls to the lot of any one in these days, though Barrow and Eastbourne, and on a smaller scale, Port Sunlight, Letchworth, and other places, have been laid out and developed during the lifetime of the present generation. Speaking generally, it is to the newer countries, such as America, or our colonies and dependencies, that the town planner must look for the best opportunities for showing his skill in the designing and laying-out of new towns and cities.

The laying-out of Delhi as the capital of India, and of the Federal Capital of Australia, are two of the largest and most recent schemes offering scope for the present day town planner, and it is a matter for congratulation to all members of the Institution that one of their Past Presidents should have been honoured by the Government as being the first man selected for the work of laying-out Delhi. That the work of Mr. Brodie and the gentlemen associated with him in the laying-out of Delhi will be of the greatest interest and be extremely useful to all members of our Institution there can be little doubt, and it is sincerely to be hoped that at some future time Mr. Brodie will be able to give to his brother municipal engineers the benefit of his experience in the laying-out of this historic city.

Although the conditions of the competition recently promoted by the Australian Government for laying-out the Federal Capital were not sufficiently inviting to induce many Englishmen

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to submit schemes, the competition still offered one of the few opportunities for putting into practice on a large scale the teaching of the past few years on town planning. Though the Federal Capital will probably never equal the size and magnificence of Delhi, it is still of sufficient importance to afford great scope for the skill and imagination of the engineer and architect; while it presented an opportunity for a young man to try his "prentice hand" that may rarely fall to his lot in the future.

The Author is not prepared to claim any great merit for the scheme which is described in the latter portion of the paper, and for which he was jointly responsible; but he is hopeful that the experience gained in its design will be helpful to his fellow-students, if not to the older and more experienced members of the Institution. Experience is the best teacher, and it is only by actually sitting down to design such a scheme that one finds out his limitations and the difficulties with which the subject bristles, or learns how to apply the experience and teaching of past and present town planners to the requirements of to-day and the future.

It may be laid down as an axiom that each particular town or city will have some special characteristic or distinctive feature, that will influence and dominate the whole design. The social, civic, and industrial character of the city, and its situation and general topographical character have all to be carefully considered, and given their proper importance and place in the design. While some special feature is almost bound to predominate, there are still many features common to all cities; and it is possible to lay down something like general rules, while recognising that exceptions will have to be made in particular cases. Among the first essentials for all well-planned towns are:—

1. The provision of an adequate water supply.
2. An efficient sewerage and drainage system.
3. Proper sanitary arrangements, scavenging, and the removal and disposal of house refuse.
4. The construction of main, secondary, and residential roads, and streets and bridges.
5. A railway system, tramways, or other means of communication.
6. Gas and electricity for lighting or power, and hydraulic, pneumatic, or other forms of power.
7. The provision of parks, recreation grounds, and open spaces

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8. Public, industrial, and residential buildings, the necessity
for architectural and artistic treatment of the public and privat
buildings, parks, etc.

In order to prepare a town plan for carrying out these wor
it is first necessary to define the area to be dealt with, estim
the probable growth and development for thirty or fifty ye
and decide upon the character of the town. The site having
carefully selected with due regard to obtaining a good su
of water, disposing of the sewage, and the convenience and a
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and a plan made, preferably to a scale of not less than
showing all the natural features of the area, such as wood
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The [illegible] systems of town planning, with the [illegible] in the former case, and [illegible] lines and gradients in the latter, each [illegible] in this, as in other matters, [illegible] bound to any one system. [illegible] found that the rectangular and [illegible] central and business [illegible] outskirts of the town is [illegible] residential [illegible] district and adds [illegible]

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8. Public, industrial, and residential buildings, the necessity for architectural and artistic treatment of the public and private buildings, parks, etc.

In order to prepare a town plan for carrying out these works it is first necessary to define the area to be dealt with, estimate the probable growth and development for thirty or fifty years, and decide upon the character of the town. The site having been carefully selected with due regard to obtaining a good supply of water, disposing of the sewage, and the convenience and amenities of the population, the area should next be carefully surveyed and a plan made, preferably to a scale of not less than 1/2500, showing all the natural features of the area, such as woods, trees, rivers and streams, or hills, and giving contour lines at every 5 feet or 10 feet. Models of the site are unnecessary where a plan contoured to every 5 feet is provided. If a river or stream runs through the site the flood level should be shown, and in the case of a seaside town or tidal river the H.W.M.O.S.T. must be given.

Having obtained our contour plan with the natural features of the site, we next proceed to locate the different areas, such as government, civic, commercial, residential and industrial areas. With the growth of imperial officialism it is probable that most large towns will in the near future require an area for government offices; but, except in the case of a capital city, these can generally be combined with, or merged in, the civic area. In a capital city the Houses of Parliament with the Government offices will occupy the most important position, and these with the civic area embracing the city hall and municipal offices should have a central and dominating position. The commercial and shopping area will generally be best placed between the civic and residential areas, and the residential area will occupy the zone outside the central area and extend to the outskirts of the city.

The industrial area should be located so that the prevailing winds will carry away the smoke from factories without nuisance to the residential or other areas. Its convenience to railway, river, or canal is a matter of great economical importance to the industrial interests, as well as of convenience and comfort to the residents generally, by avoiding carting goods through busy streets. The planning of the principal streets and boulevards is perhaps the most important part of the laying out of a city. When the city is to be large and important its beauty depends very

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largely on the laying out of its streets, boulevards, bridges, and parks. The direction, width, gradient, and the laying out of the streets so as to provide vistas of the principal buildings, and the provision of squares, circuses, and crescents, are important points and call for very careful consideration. The question of straight or curved streets is one very largely of convenience versus picturesqueness. Generally, it may be said that in the business areas the streets should be wide, direct, and have as easy gradients as the physical character of the site will permit; while in the residential areas curved, irregular, and undulating streets will add to the beauty of the district, and will frequently prove more economical in construction.

The formal or informal systems of town planning, with the streets laid out rectangularly or radiating in the former case, and as rings or with irregular lines and gradients in the latter, each have their advocates. The wise course in this, as in other matters, is to avoid extremes and refuse to be bound to any one system. In practice it will generally be found that the rectangular and radiating systems are most suitable for the central and business areas, while the ring boulevard on the outskirts of the town is most convenient, and irregularity of planning in the residential portion of the town enhances the charm of the district and adds to the amenities of the residents.

The widths of the streets, while mainly governed by the traffic requirements, must also be considered in connection with the size and architecture of the buildings. Tall or imposing buildings placed in narrow streets not only lose in architectural effect, but suffer from a sanitary point of view through want of light and air. On the other hand, too wide streets in working-class districts tend to the building of high tenement houses and flats, and overcrowding. The cost of the land as well as the cost of construction of streets must be borne in mind in deciding the width of streets, for where land is practically obtained for nothing and materials obtained on the spot as in the case of the Federal Capital of Australia, a greater width can be provided than in the case of London or Berlin, where land is costly, and materials are only obtained from outside the city. The sale of the land for building purposes, again, places at the disposal of the Australian Government funds for laying out the streets, bridges, and parks on more generous lines than the town or city where the land belongs to a number of private owners.

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The majority of the bridges in London and throughout the country are too narrow for the traffic they carry, and in the case of a capital city, it is desirable that the bridges should be of an imposing width, and of a monumental character.

The disturbance of the roadways of our principal streets through making connections for water, gas, electricity and other purposes, is a source of great inconvenience to pedestrians, a danger to vehicular traffic, and an injury and loss to all engaged in business in such streets. That subways should be provided for pipes to avoid breaking up the roads is certainly desirable in the case of new cities, and in these days of coal and transport workers' strikes it will be a great advantage to be able to transport coal or other necessaries by subway. In many towns, as at Chicago, underground railways or subways would allow the goods stations to be located some miles outside the city, and the goods conveyed to the doors of the users in various parts of the town without interfering with the traffic in the streets. It is not desirable to have underground railways for passengers, but this can only be avoided in large towns by having roads of ample width to allow tramcars or motor 'buses to run without interfering with other traffic.

The tramway, trackless tramcar, and the motor 'bus will probably all find a place in the design of an up-to-date city. The tramway is likely to be most economical and convenient in the central and busy parts of the town, while the greater flexibility and saving in track of the trackless trams or motor 'buses make them preferable for serving the outlying districts of the city.

A central railway station, with suburban stations convenient to the residential areas, is required. The goods station or marshalling yard should be placed at a spot where it taps the goods traffic coming into the city, and it should be convenient to the industrial area, with rails running into the chief factories or workshops, so as to save cost of transhipment, or carting through the city.

Parks and recreation grounds are needed in all cities, and as far as possible all natural features, such as trees, forests, watercourses, hills, or ravines, should be preserved, and incorporated in the design of the parks. Low-lying land near a river which is unsuitable for building purposes can generally be utilised for recreative purposes, and forests and hills form a natural belt of

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woodland and park which not only present a splendid outlook from the city, but tend to preserve the health and amenities of the inhabitants.

The chief religious and educational buildings should be grouped together, and the cathedrals and university should have dominating positions so as to form a good landmark from all parts of the city. Smaller churches and schools should be located in various areas suitable to the requirements of the district. The art gallery, museum, library, and places of entertainment should be centrally situated, with baths, drill hall, fire station, markets, hospitals and cemetery in convenient spots.

The water supply is of great importance, and whether this can be obtained from the hills or lakes as an upland surface supply, from wells or springs, or from a river, can only be decided by a careful study of the physical character of the locality, with full particulars of the rainfall over a number of years, and a thorough knowledge of the geological formation. The selection of the gathering grounds, river, or wells, with sites for impounding and service reservoirs, filters, or pumping stations, and the arrangements for the distribution of water, all call for the expert services of the engineer.

The question of separate supplies for potable, trade, or sanitary purposes will also have to be considered; for unfiltered water can not only be used safely for many purposes where pure filtered water can now be badly spared, but it may also be possible to utilise many sources where the chemical or bacterial conditions make the water unsuitable for drinking purposes.

The sewerage system and the disposal of the sewage are important matters in the laying out and planning of a town. The engineer designing a scheme for a new city will, in the laying out of his roads and streets and the allocation of his different areas, constantly have to keep before him the lines and gradients of his sewers, and the position of the outfall or sewage disposal works. The obtaining of a purely gravitation scheme and avoidance of pumping if possible, are points which will require his careful consideration.

Storm water is frequently more difficult to deal with than sewage, though, where a river or good watercourses are available for discharging into, they simplify the difficulty to a great extent. On the other hand, the river or watercourse is frequently an additional source of trouble, owing to the necessity for prevention

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of flooding in the districts adjoining the river or watercourse. The impounding of the flood waters by reservoirs or lakes, or controlling the floods by raising the embankments of the river, and incidentally making possible the reclamation of low-lying lands for parks or recreation grounds; or for the provision of weirs for holding up the river waters for boating and other purposes during the dry season, all call for engineering skill and experience.

Scavenging and watering of streets play an important part in the well-being of any town, and the provision of suitable means for transporting and disposing of the scavenged materials, or for watering and washing the streets, has hardly yet received that close attention and study which it deserves.

The collection and disposal of refuse is another problem waiting fuller consideration. While the introduction of the refuse destructor has made a great improvement in the disposal both from the sanitary and economical point of view, the method of collection still leaves much to be desired. No method of house-to-house collection, with its vast amount of hand labour and untidy littering of the streets, can be considered satisfactory. It is not only desirable, but it also appears practicable and economical to provide for the removal of all dust and household refuse by pneumatic power, worked on the vacuum system. The vacuum cleaner has been in use for several years for removing dust from domestic articles. Sewage is now drawn to a central station by vacuum pumps at several places; and as we have pneumatic tubes for the conveyance of letters and parcels, there is no reason why the system should not be adopted for refuse collection in preference to the unsightly and insanitary method of loading by hand into carts or vans. The refuse would be simply tipped into a bin or hopper at each house or shop, connected to the pneumatic tube and controlled by valves, and be drawn to the refuse destructor, where it could be fed directly into the furnaces without handling. The steam generated from the destruction of the refuse would be sufficient to provide the greater part of the power required for the vacuum pumps, and it would therefore prove to be a very desirable, sanitary, and economical method of collection.

The paper up to the present has dealt chiefly with the engineering and purely practical portion of town planning; and while it can certainly be claimed that these are not the least

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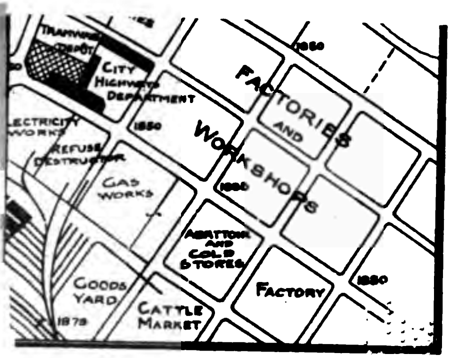
PLATE Nº 2.



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important, it can readily be admitted that the architect, sculptor, and landscape gardener have an important part to play in the development of the town.

The engineer is mainly responsible for the laying out and utilitarian portion of the town planning, but for the completion and ornamentation of the town we turn to the architect, artist, and sculptor. The engineer and surveyor must provide opportunities for the exercise of the skill and taste of the architect by laying out wide streets, leafy boulevards, and stately squares on which he can erect his buildings. Buildings for national, municipal, ecclesiastical, educational, and entertainment purposes offer full scope for the architect to exercise his powers of design and artistic leanings without encroaching on the domain of the engineer and surveyor; while the domestic buildings give him an opportunity for displaying the commonsense and good taste which has placed English domestic architecture in a class by itself. The battle of the styles may be left to the architects to fight out, but it may be said that a due regard must be paid to climatic conditions, the development and use of local materials, and historical associations or local usage. The use of statuary or monumental work in the adornment of the public, ecclesiastical, or other buildings, in the public parks, gardens, squares, and bridges, must be on generous as well as artistic lines, though unfortunately economical rather than artistic considerations too frequently prevent the sculptor being given the full and proper opportunity his art demands. The landscape gardener also cannot be ignored in laying out large parks or gardens; for a knowledge of plants, trees, shrubs, and flowers must be combined with artistic feeling and the power of planning, while the natural beauties of the site must be carefully preserved.

Description of Scheme for Laying out the Federal Capital of Australia.

The Federal Capital City of the Commonwealth of Australia is to occupy an area of about sixteen square miles, of which about nine square miles is dealt with in the scheme shown on Plate No. 1. An area of about nine hundred square miles lying about seventy miles from the sea and one hundred and fifty miles south-east of Sydney in the Yass Canberra country has been reserved as Commonwealth territory, and it is in the northern portion of this country that the Capital City is to be laid out.

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The population to be provided for is 25,000, and in the scheme now described it was estimated that this population would be reached in some fifteen years, 50,000 in thirty years, and 100,000 in fifty years. The principal plan presented for the guidance of the competitors was a contour plan to a scale of 400 feet to an inch, which showed the Molonglo River flowing practically through the centre of the city, the flood levels, the chief watercourses, woods, and hills, the suggested position and levels of the railway, the geological formation, and the contours of the site at every 5 feet.

Several other plans were given showing the position of the Commonwealth territory; a topographical map of the territory to a scale of one mile to an inch; a contour map of 20 chains to an inch, and maps showing the rainfall and temperature statistics, and a geological survey of the site. A very full description of the requirements of the city was given with the conditions of the competition, and reports on the geology and rainfall of the district were also supplied.

Models of the site of the city were exhibited in Australia, London, New York, and several colonial and continental cities. The model exhibited in London afforded very little additional information beyond what could be obtained from the large contour plan, and although the principal features of the scheme were settled on the contour plan before the model was inspected, there was no necessity to alter any of these as the result of the inspection. The scale of the model was a natural one, and on the small scale to which the model, representing some nine or ten square miles, was necessarily plotted, 50 feet rise or fall was scarcely noticeable. The contour plan to a scale of 400 feet to an inch was issued in duplicate, on one of which the laying out of the city was to be shown, and this was practically the only plan necessary with the full information given in the instructions to competitors. The capital city is to be the seat of Government, with Houses of Parliament, Government Offices, and Courts of Justice; and except for the manufacture of government stores is hardly likely to have any large industries within its borders. It will be essentially a residential city.

The Molonglo River runs through the middle of the site, which is surrounded with well-wooded hills, rising from 800 to 1000 feet above the level of the river. The prevailing winds are westerly and south-westerly, and are very cold and biting

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in winter, and these had to be fully taken into consideration in allocating the different areas, and fixing the sites of the main buildings.

The Houses of Parliament were located on Camp Hill, south of the Molonglo River, the position being central and dominant, well sheltered by a natural belt of trees from the cold westerly and south-westerly winds in winter, and open to the cooling north winds in summer. It is approached by easy gradients from, and within easy reach of, the central station, and commands fine views of the Molonglo River and the distant wooded slopes of the Black Mountain and other hills on the north. The Government offices are grouped together convenient to the Houses of Parliament, facing the Parliament Square and The Mall. The Post Office and Courts of Justice are near the central station, and the State House, Art Gallery, Museum, and Reference Library lie between the Houses of Parliament and the Church of England cathedral and the university. A Roman Catholic cathedral is situated to the south of the Houses of Parliament, and the road devoted to clubland, shown as Pall Mall.

The Government and civic areas are kept distinct, though both are fairly central, one on the south and the other on the north side of the river. The City Hall is placed on rising ground north of the river, a few feet lower than the Houses of Parliament and presenting from them a fine vista through The Mall and High Street. All the city officials would be housed here, and a large public hall would be provided in the centre of the building. In the City Square the police courts, free library, technical school, banks, and offices would present a fine opportunity for architectural effect.

The commercial and shopping area lies between the City Hall and Molonglo River, arcades running between the main streets. The markets are near the centre of the city and on the tram route. Small shopping centres are provided on the outskirts of the city. Sites for offices, banks, and hotels are provided, the chief hotels and pensions being near the central station and facing the lake and gardens near the centre of the city.

The chief residential area is south of the Molonglo River, and west of the railway. The Governor-General's house is placed in grounds of about one hundred acres in area to the south of the park and Houses of Parliament, and the Prime Minister's and other Ministers' houses face the west side of the park. The

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plots are laid out for detached or semi-detached houses, and the size of the plots varies from some seven hundred feet square to the labourer's cottage or bungalow with thirty feet frontage and one hundred and forty feet depth. The building lines vary from twenty-five feet to one hundred and twenty feet, according to the size of the house and depth of building plots. As all houses are detached or semi-detached, no back streets are required save in the shopping areas.

The industrial area is located near the south-eastern entrance to the city between the railway and Jerrabomberra Creek. The chief goods yard or railway marshalling yard is near this point, and as the bulk of the coal and materials coming into the city will be required for industrial purposes, it is a matter of great convenience and economy, and avoids carting through the city. The prevailing winds will take away the smoke without nuisance to the residential area. The gas, electricity, and refuse destructor works, tramway depôt and car shed, and Government factories are located in the industrial area, and connected with rails to the goods yard. The cattle market, abattoirs, ice factory, and cold stores, are also placed near the goods yard.

The main streets in the Government and commercial areas are generally straight and direct from one important point to another, The Mall, connecting bridge, and High Street, form a continuous straight line between the Houses of Parliament and the City Hall; though the view would to some extent be broken by clock towers in the Station Place and at the north end of the bridge. Two boulevards, east and west of The Mall, radiate from Parliament Square, while the City Hall is the radiating point for eight streets. The two cathedrals form the focal points of important streets or avenues, and in the smaller squares, crescents, and circuses, the vista is formed by churches or other important buildings. The chief buildings being built on elevated sites are visible from various parts of the city, while good views of the parks and river are commanded from large portions of the district.

The contours of the site are such as to make the gradients of many of the roads somewhat steeper than desirable; but, except in one or two cases, it is possible to get gradients not steeper than one in twenty-five; and in the business area the steepest gradient would be one in forty. The main streets and boulevards are laid out of a sufficient width to meet the

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requirements of the larger population which it is expected the city will ultimately reach, and the sections on Plate No. 2 show that they will be largely laid out as tree-planted boulevards or avenues with grass or gravel margins, or central plots.

In a hot climate such as Australia shelter from the trees is very desirable, while the tree-planted space costs little to lay out, and is always available for throwing into the roadway should the traffic in the future require the widening of the road. The roads have been given a width which may seem somewhat excessive to English ideas; but it must be borne in mind that the land costs nothing, that the city is the capital of a country which is a continent, that suitable road materials may be obtained on the spot, that the revenue from the sale of the land is available for the roadmaking, and that the roads are largely planted with trees, or laid out as lawns. There is, therefore, no reason to adopt the cheese-paring ideas of many of the promoters of Garden City competitions, either with regard to widths or materials for roadmaking.

The principal road, "The Mall," is a fine open boulevard 400 feet wide. The main feature of this road is the central lawn, 100 feet wide, laid out with flower beds, fountains, and statuary. Footpaths 25 feet wide are planted with one row of trees on each side of the 40 feet roads for slow traffic and service to the Government buildings. Two further strips, each 35 feet wide, laid out with three rows of trees as avenues or promenades, adjoin the 50-feet roads on each side of the central lawn. These roads provide space for quick traffic, half of the road being macadam for horses and the other half tar macadam for motor traffic. The High Street, which is the chief shopping centre, is 200 feet wide, has 25-feet footpaths, two 50-feet roads, and a central tree-planted plot 50 feet wide, on to which passengers will alight from the tramways. Other shopping streets are 120 feet, 100 feet, and 80 feet wide according to the importance of the position and the traffic. In each case a large portion of the streets is taken up by grass and trees, which lend beauty to the streets, provide shade, and save expense in street making. The arcades, which are 30 feet wide between the shops, would have rolling stairways to transport customers or clients to the shops or offices above the shops on the ground floor. The main ring boulevards are 150 feet wide with 20-feet footpaths, two 30-feet roads, and a central plot 50 feet wide with 10-feet gravelled footpaths and 30-feet grass plot in which the tramways

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are laid. Trees on the footpaths and on the sides of the tram track make a pleasant avenue. Other roads are 100 feet, 80 feet, 60 feet, and 50 feet wide, according to requirements and importance. The Park Drive is laid out 150 feet wide with 25-feet footpaths, two roads each 30 feet wide, and a central riding track 40 feet wide.

Subways, as shown on Plate No 3, are provided for the Government and main business roadways. Under The Mall and the road east of Pall Mall the main subway is made wide enough for coal trucks drawn by a small electric locomotive, and the pipes are carried above on rolled steel joists. Pipes for water, gas, electricity, and hydraulic power, pneumatic tubes for house refuse, or postal purposes, telegraph and telephone wires, and in the near future, petrol and liquid air, may all be provided for. On the north side of the river the main subway under the High Street is simply a pipe subway, and both main subways give access to the main sewers. Secondary or shallow service subways are provided for pipes on each footway adjoining the shops, and private subways are shown to the Government buildings and clubs.

The main bridge over the Molonglo River and across the lake, shown on Plate No. 4, is 150 feet wide on plan, though it is actually only 100 feet wide, as it consists of two 50-feet wide bridges with an open space 50 feet wide between them. The roads are connected at intervals of 100 yards alternately with footways and carriageways carried by arches harmonising with the bridge arches. This arrangement allows the traffic to continue over the bridge in a straight line instead of being diverted by the contraction of the road from 150 to 100 feet, where the bridge and road meet. It gives more light and air to the roads, river, lake, or gardens under the bridge, and lessens the tunnel-like character of the arches of the bridge. It allows a bridge of a somewhat novel and unique type to be constructed at a cost of little more than the 100-feet wide bridge, while presenting the appearance of a 150-feet wide bridge. It also affords opportunities for artistic treatment of balustrades, piers, and lamp standards. Pipe subways are placed under the footpaths. Other bridges are 80 feet and 50 feet wide, and footbridges are provided at several points over the railway and river.

Tramways are provided to reach the suburbs, and on the

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ring boulevards they are laid in the grass plot, which not only makes easier running and gives a pleasanter outlook, but saves enormously in the construction and maintenance of the track. The line and levels of the railway were suggested on the plan issued to competitors, and it was only necessary to alter the levels to provide headroom for the roads running under the railway bridges, or the railway under the road bridges. The Central Station is practically in the centre of the city, and suburban passenger stations are placed 1½ miles north and 1¾ miles south of the Central Station.

The railway marshalling yard or chief goods yard is located at the south-eastern entrance to the city in the midst of the industrial area, and large warehouses are erected there. Small goods yards are placed at the central and northern stations.

Ample provision is made for parks and recreation grounds, and the natural belt of woodland and park on the outskirts of the city will assist in the future development of the city. The chief park is located at the rear of the Houses of Parliament enclosing the hill called Kurrajong, and has an area of about 200 acres. It is well timbered and watered. The trees would be preserved as far as possible, and the watercourses would be made a picturesque feature with waterfalls, ferns, etc., as well as being used for storm-water purposes. A botanic garden, aviary, observatory, shelters, and bridges, with fountains, conservatories, and shrubberies add to the attractiveness of the park. The roads are laid out as avenues for pedestrians, riders, and vehicular traffic. Smaller parks and gardens are provided in various parts of the city, and in the squares, crescents, and circuses, small enclosed gardens are shown. Large ornamental gardens with boating lake, bandstand, fountain, and terrace, are formed near the centre of the city adjoining the river. This land is below the flood-level and is protected by a broad tree-planted embankment and roadway. The land below flood-level has practically all been reclaimed and reserved for recreation purposes; the stadium, cricket, football, and golf grounds, military exercising ground, racecourse, and show ground all being located in this area.

The Church of England cathedral has a church house and Bishop's residence near to it. The Roman Catholic cathedral has a presbytery and convent school adjoining, and there are churches in suitable situations for the other denominations. A

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university, high school, technical school, and four elementary schools are provided.

A national theatre and a music hall are situated near the Central Station, and sites for other places of entertainment are provided in other districts. The barracks, gaol, and mint are placed near the eastern boundary, and drill halls are located convenient to the military exercise grounds and rifle range. A sanatorium, infectious diseases hospital, general hospital or infirmary, and cottage hospital are provided in suitable situations. Central baths and three open-air bathing places, a cemetery containing three chapels and a crematorium, and a fire station, are also shown.

The Molonglo River is converted into a series of large lakes by impounding the river water by weirs. These hold the water up to such a level that it will make the river suitable for boating and bathing for about three miles, though at the same time the levels of the weir are kept sufficiently low to prevent flooding.

There is a considerable fall from the east to the west of the city, and no difficulty should be experienced in providing good falls for the main and other sewers, and avoiding pumping. The northern sewer would have to be carried across the river near the western weir, either by means of an inverted syphon, or by steel pipes supported on cast-iron piles and columns. The sewage disposal works are to be located some six miles west of the city. Storm water should be treated separately, and as far as possible the natural watercourses should be used for the purpose of storm-water drainage. They all empty into the Molonglo River, and where they run under the roads they will be culverted, or in some cases bridged over.

The collection of refuse from the Government and shopping areas would be by a suction pipe worked from the destructor works by a vacuum pump as described at page 48. The system might be extended to the residential areas, but if not, carts, vans, or motor waggons may be employed. For street watering and gardening purposes special pipes should be laid in the principal streets, boulevards, and gardens.

A longitudinal section to a natural scale of 100 feet to an inch, which though not reproduced in this paper it is hoped may be published in the Proceedings, was given from the Houses of Parliament to the City Hall. This drawing showed in section

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the Houses of Parliament as a domed building in the classic style, with terraces, gardens, and fountains in the Parliament Square and facing the Park; elevations of the Government offices; the colonnaded Station Square, with clock tower, and Station Hotel; the main bridge over the gardens, lake, and river; the banks and shops in the High Street; and a section through the City Hall. The style of architecture suggested for the public buildings was classic, or the adaptation of it known as renaissance, and the banks, hotels, and business premises were a somewhat freer type of the same style.

In conclusion, the Author hopes that the consideration of town planning in the wider and general view which he has attempted to place before the Institution, may prove to be of service even to those who are called upon to deal with only a small or partial scheme. The principles which underlie all sound planning are of wide application, and it is the study of these principles combined with common sense and experience which can alone produce the ideal town plan.

DISCUSSION.

MR. J. W. COCKRILL: In these papers we have a lot of information on the subject of town planning. In Sheffield they have a problem to deal with which they would not have in more level towns. There is much land with which it is impossible to do anything but leave it open. The work done by Mr. Wike is of a very good character, as we said at West Bromwich last year, where we had the pleasure of seeing the original plans. I move a vote of thanks to Mr. Wike for his paper.

MR. W. H. GRIEVES: I will second that. Mr. Wike mentions negotiations with the owners of large estates. He goes on to say that "except in one or two cases, arrangements have been made satisfactory to both parties, the Corporation agreeing to slightly modify their requirements with regard to the number of houses to the acre, set back, etc., the owners throwing out the necessary land for widening the roads to the widths agreed upon, and the Corporation paying for the street works over the width required by the by-laws, *i.e.* forty feet." What I would like to ask Mr. Wike is whether the Sheffield Corporation induced every one concerned to give up the land

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without paying compensation, because if that is so they have done extremely well. That is going to be one of the great problems with regard to the widening of roads. In a scheme in my own district which is in course of preparation we want the owners to give up a certain width of land on a main road to make it at least 60 feet wide, but the amount they name is excessive, and we cannot possibly consider it. We do not want to use the arbitration part of the Act if we can get the land without. It would be interesting to know if there has been any difficulty of that kind in Sheffield, or whether the owners were persuaded by conciliatory methods to give up the land without paying anything. Our by-laws will not allow a road to be made of less width than 50 feet, but it has been suggested that we might allow owners who are prepared to give up land for the widening of the road to make streets from thirty to forty feet wide. I should like to know if any member has had experience of an agreement of that kind. Mr. Wike says it scarcely seems fair or reasonable to fix a limit of twelve houses to the acre for the area adjoining another area where there are as many as thirty-five houses to the acre, and the Corporation have therefore fixed a limit of twenty-four to the acre for this part, which, under the circumstances, seems a fair thing to do. With respect to the set back of fifteen feet mentioned, I think it should be twenty or twenty-five feet.*

MR. E. R. MATTHEWS: Mr. Wike says a special Town Planning Sub-Committee of the Sheffield Corporation was appointed to deal with this question. I should like to ask whether any portion of the town planning area is outside the City boundary, and, if so, whether the Rural District Council or the County Council or other authority affected were asked to appoint delegates to co-operate with the sub-committee? My own Council, who now have a town planning scheme in hand, are making proposals of this kind designed to get rid of the opposition of the Rural District Council and County Council at the outset. They intend to seek the co-operation of these Councils, and they have

* Mr. Grieves writes, "*Since the above discussion my Council have agreed to give 500l. for a strip of land to widen the London to Brighton main road about half a mile long, by 15 or 16 feet in order to make it 60 feet wide, and the Road Board and the County Council have agreed to contribute towards the purchase and the making up of the road. In addition to which the owners of the land are laying out 100 acres on garden city lines with 8 to 9 houses per acre. The houses will be set back so that there will be a clear width of 70 feet.*"

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been asked to appoint representatives to serve on the town planning sub-committee. In this way we hope to avoid the opposition of both the Rural District and the County Councils. Mr. Wike suggests that it is wise to divide the portion of the town intended for town planning into sections, taking two or three in hand at first, and others from time to time. I would like to ask if he still thinks that the best plan to adopt. We had rather a discussion on that point in my own Council, and the decision come to was that the whole area should be planned at one time, although fifty years may elapse before part of the area is likely to be built upon. I have great pleasure in supporting the vote of thanks to Mr. Wike for his valuable paper.

Mr. A. H. Campbell: I think I am correct in stating, in reply to the question by a previous speaker as to how to get owners to surrender their land, that no compensation is payable under the Act when a strip of land is given up under such conditions as those alluded to. In reply to the question about the county and the rural districts, the whole of the area dealt with in the scheme Mr. Wike describes is within the City of Sheffield's boundaries.

Mr. Picton: I should like to ask Mr. Wike why the new road shown in Plate I. is curved? I would also ask if the authority considers that the limit of 24 houses per acre will have any effect on building operations in the city? In the outskirts of Manchester it is a common practice with owners and builders to erect forty houses per acre, giving 110 square yards to each building, and I do not see how it can be prevented unless each municipality adopt the Town Planning Act. I think that should be done, for it is not at all desirable to have as many as forty houses to the acre; it is much better to have only twenty-four. I now have much pleasure in moving a vote of thanks to Mr. Price. It shows how carefully Mr. Price, senior, has trained his sons when we see the remarkable ability displayed by young Mr. Price in connection with the scheme for laying out the federal capital of the Australian Commonwealth. When we have juniors who show such abilities as this, municipalities need not fear to appoint them to succeed older men. I cannot say, however, that I see eye to eye with Mr. Price in putting down a tramway track on grass plots. In Lancashire towns that certainly would not do at all; it would mean such an awful expense.

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Mr. A. H. Campbell: I will second the vote of thanks to Mr. Price. It is well for our Institution that we have such a junior member, capable of taking so admirable a part in the discussion of the subject of town planning. I have not heard whether this plan was premiated or not; but it certainly deserved a premium, if it did not get one. It is very gratifying that town planning has been given such prominence at the last four annual meetings of the Institution, culminating in the successful conference at West Bromwich last year. I hope the question will for many years continue to form an important part of our programme at the annual meetings. We are only on the threshold of it, and the more we go into it the greater will be found the possibilities of the Act in the direction of furthering the good government and improved administration of our large cities and towns. The Act of 1909 forms a renaissance in public health legislation. It comprehends not merely public health in the narrower interpretation of the term, but public health as involved in the whole question of governing an urban community. It deals not only with city improvements, but with the widening of city main roads, the construction of new inter-communicating ways between severed parts of cities, and with the distribution of population, the relieving of that congestion which is found in all big urban communities by spreading the people over the less built up areas. It also enables us to create open spaces and conserve the amenities of our towns. Consider what it means with regard to economy as affecting the good government of our cities. Formerly, if we went to Parliament, we were faced with wretched red tape and hide-bound official methods, and how little that was new could we get into local legislation, because, as they said, there was "no precedent" for it. Then, if there was a precedent of ten, twelve, or fourteen years back they would say "we are not granting this to-day, because we are so advised by the central authority." I am glad to see that now the central authority has surrendered to the pressure of local opinion, as voiced by the municipality. The Association of Municipal Corporations, about the year 1907, had, as one of the subjects for discussion, that of Town Planning. That brought the question to the front, and induced Mr. Burns to go forward with this new birthright for the municipalities of the country. The point mentioned by Mr. Matthews, about over-lapping authorities, is an important one. We in Edinburgh are

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experiencing the same thing that he mentioned. I think it is a pity that there should be such rivalry and unneighbourliness between authorities as to prevent the carrying out of what would be for the benefit of all the authorities concerned; and I deprecate the setting up of rival plans and competitive schemes to the detriment of the common good. I hope the prevailing tendency in the future will be to refuse to countenance rival schemes, and to institute joint authorities, so that coalition will take the place of rivalry, and co-operation of hostility. Mr. Price deals with the case of an entirely new town, and I congratulate him on his work. That brings me to another aspect of the question; we who hail from Scotland have the satisfaction of knowing that she is going to take the lead in town planning in the United Kingdom. There are seven thousand acres ready for planning in connection with the development of Rosyth, where the Admiralty is pushing the authorities along with all possible speed. In the course of a few years a stretch of country which is now green fields, will have a population resident upon it, of from 40,000 to 50,000, who will be—I will not say aliens—but from the midland and the south. I am glad to think that the gentleman who is carrying on that scheme is English (from Mr. Stilgoe's office), *i.e.* Mr. Wilkes, who is applying himself with all the energy and knowledge derived from his experience in the south, to his task in this northern city, and he is going to lay out there an absolutely new town, to receive these guests from the south. Well, all of us have not seven thousand acres or federal capitals to deal with, but we all have our little lots to till, and therefore let us not be discouraged. Each even of our towns—small or big—presents opportunities for the consideration of the same problems as if the area were ten or twenty-fold as large.

Sir James Lemon: The objects of town planning are twofold, to prevent slums in the future, and provide better housing in the suburbs, and to get direct communication with the main roads in the surrounding districts. I happen to know three estates with a good road running round the three of them, and the owner of the centre block proposed to lay out his land, and wanted the two other owners to join with him so as to get through roads. The others said, "We are not in a hurry; you develop your land first, and then we will have a go." Now under the Town Planning Act that will be prevented, and all

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three estates will be developed. As regards the width of roads, Mr. Wike gets over the difficulty pretty well. It is a great step in advance to have a road eighty feet wide; we never thought of such a thing some years ago; I know I had great difficulty in getting them 40 feet wide. After most of the owners had been induced to go beyond forty feet there would be one obstinate landowner who would not budge, but the difficulty in his case was got over by an agreement to put a good forecourt on the road. I got one gentleman to make a road fifty feet wide, and as there was a forecourt in that case of ten or twelve feet, they got a total width of practically seventy feet. What you want is really not so much a great width of road, as a great width between house and house. I have laid out an estate on which the owner wished to put as many houses as possible, and I persuaded him to give a road 50 feet wide, with forecourts on each side 25 feet, so that the total width between the houses was brought up to a hundred feet. When you meet with landowners who will not increase the width of the road so much as you think they ought to do, you can get over the difficulty in this way. The suggestion is a good one, that when local authorities want a greater width dedicated to the use of the public they should pay for making up the increased width above what the owner wants to give. By all means come to an agreement if it is possible to do so, for if you have to go to arbitration it will be a very expensive matter. I believe that if you negotiate with the owners in a reasonable spirit you will not have much difficulty in increasing the width of roads as much as you wish. With regard to the number of houses, I consider twenty per acre is the maxium under any conditions whatever; indeed, I go further than that, and say that twelve would be much better. We want to spread our towns out; not to have a lot of houses crowded on a small area, and I think we ought to work in that direction.

Mr. W. Stubbs: The scheme Mr. Wike describes is suitable for a large manufacturing town. The limit of 20 houses per acre is, I think, a very reasonable one. In the district I have the honour to represent the present by-laws will not allow more than 30 per acre. As to the width of roads, I think it is a mistake to make the roads too wide, as you can get a forecourt as suggested by Sir James Lemon. I do not quite agree with the suggestion to spread the laying out of the area over a period of

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fifty years. I think it is a mistake to do that, especially in parts of the country where there are many owners, as there are in Lancashire. Another suggestion I do not agree with is that for keeping works separate from houses. How is a working man who is in receipt of twenty-five shillings per week to get to work? Is he to pay five or six shillings a week in fares? If we are going to have healthy working classes we must provide in our town planning schemes for the working man, but so far as it has gone it does not provide for the working man; he must have 35*s.* or 40*s.* per week to live in the houses provided under town planning schemes.

MR. W. L. CARR: With reference to the Ruislip-Northwood scheme, which has aroused some interest, I may say that at the last meeting of my Council the draft scheme was approved. By this you will see how it is proposed to deal with the widening of existing roads, the laying out of new roads, and also with the question raised by Mr. Matthews, Bridlington. We have a road outside our district, and I am very pleased to say that though we had an objection from the Rural District Council, the Local Government Board overruled that objection, and we have now come to an agreement without any committee of the two Councils being formed. The question of factory areas, shop areas, and open spaces, are all dealt with. You will also be able to see the several agreements entered into with the land-owners, which deal with the width of the roads. Turning to Mr. Wike's paper, I should like to ask whether it is proposed to frame general provisions with regard to the area mapped out. In my opinion it is not necessary to do that. I should also like to ask him how it is proposed to deal with the limitation of the number of houses per acre. The question of set backs we are dealing with in a slightly different manner at Ruislip to that described by Mr. Wike, and I think our method is preferable.

MR. THOMAS ADAMS (Town Planning Assistant to the Local Government Board): This has been a very instructive meeting, and has helped me to understand some of the difficulties which the surveyors of local authorities have to contend with. I hope that every member of this Institution who has a town planning scheme under consideration will take the opportunity offered of seeing Mr. Carr's plans. The labour given to the Ruislip scheme must be of great value to all who are interested in schemes which are not in such an advanced state. There are,

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in connection with town planning schemes, a great many difficulties to be encountered in the later stages as well as in the earlier ones. The question of outside areas has been alluded to by the representative of Bridlington. On that point I may say that the Act clearly provides for giving authorities power to include parts of districts outside their own area in their schemes subject to the approval of the Local Government Board. Regarding the width of roads, a surprising statement was made by one of your members the other day which shows the disadvantage of having a standard width of street. He stated that 75 per cent. of the streets in his district could do with a less width than the 45 feet required by the by-laws, but that the importance of having the other 25 per cent. of the streets not less than 45 feet wide made it necessary to have this as the standard width throughout. I hope that surveyors, before preparing town planning schemes for parts of their districts, will consider their whole area in a comprehensive way, and prepare a skeleton plan for private use showing their ideas as to the line and position of arterial and other principal roads required. Mr. Wike shows in his scheme that he is not only endeavouring to deal on practical lines with the needs of the area included in each scheme, but has considered how Sheffield as a whole is going to grow in the future, and how that growth should be provided for. With reference to one remark that has been made, I do not think it is fair to say that the Town Planning Act is encouraging the building of houses suitable for others than members of the working classes. There is a great deal of misapprehension on that point. Town planning is one thing; schemes like Hampstead garden suburb are another thing altogether. Town planning deals with all undeveloped areas of towns and cities, and of course includes the industrial and working-class areas. You cannot deal with any large area in a town like Sheffield unless you make provision for housing the working classes, as well as others. The making of this provision is an important element in all town planning schemes, and has to be considered in relation to such questions as the width of roads. Wide arterial roads are not roads in which you can economically house the artisan; therefore where the frontages of these roads have to be used for small weekly property it will probably be found necessary to pay a large proportion of the cost of these roads, say such as is in excess of the cost of a 36 or 40 feet street, out of public funds. This question of the provision

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of working-class dwellings and the relation of these dwellings to the cost of development should be taken into serious consideration by Surveyors in the early stages of preparing schemes.

THE PRESIDENT: We have had a most interesting discussion on two admirable papers, one from a veteran, and one from a coming municipal engineer. I will now put the vote of thanks to you.

MR. W. H. PRICE, in reply to the vote of thanks, said: I should like to thank Mr. Picton and the other gentlemen for their kind words about my paper. Mr. Picton said something about the grass plots for the tramways. The cost of upkeep would not be very much, and the picturesqueness would make up for any expense that would be incurred.

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STANDARDISATION.

By Ernest J. Elford, M.Inst.C.E., M.I.Mech.E. (*Member*), Borough Engineer, Southend-on-Sea.

Before referring more particularly to the subjects in regard to the standardisation of which this Institution has taken an active part, the Author would like to refer briefly to the subject of engineering standards generally. The principle of standardisation has long been acknowledged and practised, probably the earliest example being standard measure of time, and as early as the reign of Henry III. efforts were made to enforce the use of standard weights and measures. In other respects, however, the principle of standardisation made little progress until comparatively recent times. In regard to engineering matters, the efforts of Sir Joseph Whitworth appear to have been the first of a serious character. By securing the adoption of standard screw threads and gauges, and by his efforts to secure greater accuracy and uniformity, he did much to facilitate the progress of engineering in this country, and indeed to lay the foundations of the vast engineering industry now possessed by this country.

Valuable and important, however, as were the results of his work, it was found that progress was being seriously impeded by difficulties and confusion arising from great divergence in the manufacture, dimensions, and use of various materials required for engineeering work. This was particularly felt in connection with the rolling of iron and steel sections of various kinds, the use of which in every branch of engineering was increasing by leaps and bounds. Every engineer appeared to think it incumbent upon him to design his own particular sections, with the result that an enormous amount of unnecessary expense was involved and serious delays occasioned.

Before the days of rolling mills, when all this class of work was forged, variations in design were comparatively unimportant, but with the introduction of mechanical means, involving heavy

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initial cost, and depending for economy upon the production of large quantities of material to one pattern, the practice referred to could no longer be justified. Many of the sets of rolls cost 200*l.* and upwards, and most of the manufacturers held hundreds of rolls which could not be used for more than one order. Special rolls had often to be cut for supplying orders for 100 and 200 tons and then scrapped. The effect, therefore, was to enormously increase the cost of production and to cause a great waste of time.

To Sir John Wolfe Barry belongs the credit of initiating a movement of reform. In 1901, he brought the matter before the Council of the Institution of Civil Engineers, and being convinced of the importance of the subject, the Council took steps to form a special committee to deal with the question. This committee includes representatives of the Institutions of Civil Engineers, Mechanical Engineers, Naval Architects, Electrical Engineers, and of the Iron and Steel Institute. The scope of the work has become very much enlarged, and there are now about forty sectional and sub-committees with over three hundred members, comprising representatives of Government departments, engineers, manufacturers, and other interested parties working under the main committee upon various branches of the undertaking. Upwards of 30,000*l.* has already been expended on the work of the committee.

The field covered includes the standardisation of rolled sections, the preparation of standard specifications for other materials, the formation of standard tests, and in one case the preparation of standard specifications for complete machines. Many of the matters dealt with are of considerable interest to the members of this Institution, notably Portland cement, tramway rails, rolled sections, cast-iron pipes, and vitrified sewer and drain pipes. Standard specifications relating to some of these subjects have now been issued several years, and there is overwhelming evidence as to their value. The specification for Portland cement is now very generally adopted, and has had the effect of causing a general improvement in the quality of material placed upon the market.

Sir John Wolfe Barry has quoted * the statement of a leading cement manufacturer as indicating the advantages following

* Lecture on "Standardisation and its Relation to the Trade of the Country," delivered before the Institution of Engineers and Shipbuilders of Scotland.

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the publication of the standard specifications for this material, and in the Author's opinion it will well bear repetition. He said—

"The result of the introduction of the standard specification has, no doubt, been to save a great deal of inconvenience to the individual cement manufacturer in reducing to a minimum the variety of odd specifications, some of them of the most peculiar and difficult character, with which he formerly had to deal, and from that point of view it is much more plain sailing for him in the production of the article which he supplies.

"Speaking for ourselves, we have welcomed the introduction of the British standard specification which is now being so largely adopted by the engineer and the consumer of cement, as, in these hard times of competition, it has equalised up the conditions under which the various manufacturers of cement have had to quote, and in specifying cement to the British standard specification, the consumer, in dealing with the tenders that he may receive for the supplies of same, knows that all the people tendering are doing so on even terms."

About seventy per cent. of the tramway rails used in this country,* and the great majority of beams, angles, tie-bars, and channels, are now rolled to British standard sections.

The Author has obtained from the manager of one of the largest rolling mills in the country the following statement of the advantages of standardisation :—

"*Standard Sections.*

"(*a*) A very great reduction in the number of sections inquired for by buyers.

"(*b*) As a result of the fewer number of sections, the amount of capital locked up in rolls (some of which only used at very infrequent intervals) is materially reduced; depreciation and other charges being reduced accordingly.

"(*c*) The smaller number of sections means less frequent roll-changing, with its attendant expense.

"(*d*) Owing to the constant demand for standard sections, it is often possible to oblige customers for comparatively small quantities, as standard sections rolled and stocked usually find an early market.

* Seventh Report of Engineering Standards Committee, p. 13.

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"*Specifications.*

"There is a great saving in working standard specifications, as these facilitate chemical control, mixtures, and similar details."

The President of the Iron and Steel Institute, in his presidential address, delivered in May last, referred to this subject in the following terms:—

"The effect has been to reduce enormously the number of sections called for, as, owing to the very representative and influential character of the committees, British standard sections and specifications have been very extensively adopted, notably by the Admiralty, the Board of Trade, and Lloyd's Register. The British Corporation for the Survey and Registry of Shipping and the Bureau Veritas have likewise given effect to the Committee's recommendations in their rules, with the result that the cost of roll stocks is being greatly reduced, and the manufacturer may now be content to roll into stock when it suits his convenience to do so, with the certainty that he will not have the material left on his hands as was formerly frequently the case when almost every buyer had his own particular section and specification, which no other buyer could be prevailed upon to take. The advantage to the consumer of the adoption of the standard sections being quicker delivery (small lots frequently from stock) and reduced cost, practically no special rolls being now required."

The significance of these opinions is enhanced when it is known that, before the publication of the standard specification, there were more than seventy different sections of tramway rails in use in this country, whereas the committee have found that five sections are sufficient to meet practically all cases. The fear has been expressed that standardisation would have the effect of so discouraging individuality of design as to seriously impede progress. As, however, except in rare cases where such a course is proved to be specially advantageous, the committee deals only with materials which are used in construction, the individual mind is allowed full scope in the use and assembling of the materials to form completed structures.

In addition, a safeguard is provided by the permanent constitution of the committee, which it is intended shall, from time to time, revise the specification in the light of later experience and development.

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Having dealt so far with the general question of standardisation, the Author will refer to that aspect of the subject which is of more particular interest to the members of this Institution.

It will be remembered that at the annual meeting held at Plymouth two years ago Mr. Paton, in his presidential address, referred at some length to the adulteration and inferior quality of various materials in general use by municipal engineers, and suggested that the Council should take up the question of standard specifications.

During the previous year a committee of the Institution had been engaged in preparing, at the instigation of the British Engineering Standards Committee, a draft specification for sewer and drain pipes, and when at the first meeting of the new Council the reconstitution of the committee was under consideration, the Author suggested that the scope of the committee should be extended to enable it to deal generally with the subject of standardisation. This suggestion was adopted, and the committee has, during the past two years, devoted a large amount of time to the consideration of this subject.

The draft specification relating to sewer and drain pipes was completed and sent to the Engineering Standards Committee, who summoned a conference of representatives of various Government departments, engineers, manufacturers and others interested in the subject. This Institution was invited to send three representatives, and on their motion the conference unanimously decided that it was desirable that a standard specification for vitrified ware sewer and drain pipes be prepared. A sectional committee was therefore appointed for this purpose.

The main committee selected as chairman of the sectional committee Sir Maurice FitzMaurice, chief engineer to the London County Council, and a number of meetings have been held under his able and sympathetic presidency.

In the course of their investigations the committee of this Institution (which the Author will refer to as the municipal committee) had accumulated a very large amount of evidence as to the inferior and unreliable quality of many of the pipes manufactured in various parts of the country, and they had been urged to do something to drive out of the market materials of this description. For this reason, in addition to various suggested tests for the finished article, they put forward the suggestion that if found practicable some chemical standard for the materials

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of which the pipes were to be made should be included in the standard specification. The committee felt that the practicability or otherwise of this suggestion was a matter upon which the opinion of the chemist and manufacturers should be obtained, and the suggestion was put forward with this view.

It is undeniable that a large number of pipes are supplied which, to the eye, appear to be quite satisfactory, but which in time deteriorate to such an extent as to give rise to serious trouble. Not long ago the Author had to relay a 27-inch pipe sewer, about five hundred feet in length, which had collapsed, every pipe of which was found to be fractured. The pipes bore the name of a well-known maker, and had been laid about sixteen years. Probably at that time they appeared to be quite satisfactory, but when removed the material was found to have become most defective.

It was thought by the municipal committee that it might be found that the elimination of certain constituents from, and the inclusion of others in, the material of which the pipes were manufactured is essential for the production of thoroughly vitrified pipes; but unfortunately the chemists are of opinion that a chemical standard of this kind is not practicable. A few years ago the best pipes, in fact it might almost be said the only pipes of high quality, were those manufactured from the Devon and Dorset clays; but since then many of the Midland and other makers have, as the result of experimental work, and the exercise of great care in the selection and blending of clays and improvements in manufacture, been able to produce pipes of the highest quality.

The terms stoneware, fireclay, and earthenware as applied to sewer and drain pipes were always more or less ambiguous; but pipes made from Devon and Dorset or similar clays were generally included under the term stoneware, while pipes of Midland and other clays were usually designated fireclay or earthenware. Since, however, the latter were so much improved in quality these descriptions have practically lost all value. The aim of the municipal committee was to prepare a specification in such terms that all first-class pipes might be admitted and all inferior pipes rejected, and to ensure that all standard pipes should be made of dense, highly vitrified material. The old names have therefore been discarded, and standard pipes are to be designated VITRIFIED WARE SEWER AND DRAIN PIPES.

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The suggested chemical standard for the material having proved impracticable, the committee had to fall back upon an absorption test, and it is hoped that this may be found both convenient and effective. One fact which has been brought to light while experimenting in regard to absorption, and which to most engineers will no doubt appear somewhat surprising, is that the salt glazing has very little, if any, effect, upon the absorption, particularly in the case of better class pipes. It was thought at first that the glazing would interfere with the proper application of an absorption test; but it has been found that, for practical purposes, the effect of the glazing can be ignored in ascertaining the absorption figure. When applying a test of this kind it is of course essential that the samples should first be dried to constant weight, and with pieces of the size proposed this can be done under a temperature of 150° C. in less than an hour. By subsequently boiling the samples as proposed, the maximum absorption is reached in forty minutes, so that the testing can be completed in a very short time.

The manufacturers on the sectional committee were not unanimous on the question of an absorption test, but a majority was in favour of the inclusion of a test of this kind.

The specification prohibits "slip" glazing, as this is generally applied to pipes of an inferior quality.

The interval water pressure test is to be adopted as a test for strength and soundness of the finished pipe, and the scale of pressures has been so calculated that the material will be required to sustain without damage a tensile stress of from 100 lbs. to 125 lbs. per square inch of sectional area. The general opinion is that for important work it is desirable to apply this test to each individual pipe, but having regard to the cost of so doing, the specification will contain alternative conditions which will enable engineers to call for pipes which have passed individually the hydraulic test and been stamped with the word "tested," or for pipes which have been made to the standard specification and are supplied as being capable of withstanding this test. The engineer will himself be entitled to select and test samples from each consignment of the latter class, but the makers will be under no obligation to apply the water-pressure test.

The specification also deals with such matters as thickness, length, shape, permissible deviations, glazing, and the marking of all pipes sold as complying with the standard specification,

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and the marking before sale of all inferior or defective pipes, and with the question of joints. The draft specification put forward by the municipal committee contained stipulations as to the dimensions and shape of sockets, but it was felt that in standardising a joint an effort should be made to improve the old form of socket and spigot, which, at any rate in the hands of the ordinary builder and estate contractor, is open to serious objection. Every engineer will agree that under proper supervision and by the exercise of care and skill in jointing, thoroughly good results can be obtained with this joint, but unfortunately hundreds of miles of house drains and considerable lengths of

Fig. 1.

estate sewers are laid without care, skill, or effective supervision, and notwithstanding this the local authority is saddled with the whole responsibility for the subsequent maintenance and efficiency of the latter.

Fig. 1 is from a photograph of the section of a joint typical of many which the Author has from time to time removed, and the defects in which are directly attributable to the large annular clearance in ordinary spigot and socket joints. That this form of joint is by no means perfect is evidenced by the large number of patent joints placed upon the market during

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the past fifteen or twenty years, some of which have been very largely used. Unfortunately, however, these improved joints are seldom if ever used by the ordinary builder and estate contractor, but are adopted generally by those who could best ensure good work with the old joint. What is wanted is a pipe with a simple, inexpensive form of joint which even when laid by comparatively unskilled and careless workmen will give reasonably satisfactory results.

A modified form of socket was suggested by the municipal committee and was approved by a large majority of the members of the Institution, who expressed their opinion in response to an invitation to do so, but on being placed before the makers it was stated by them to present difficulties in manufacture, and it had therefore to be abandoned for the time being.

For obvious reasons it is impracticable to adopt as a standard joint one which is covered by existing patent rights, and it is probable that the sectional committee will recommend a simple form of Stanford joint, the manufacture of which is now quite unrestricted. The cost of these pipes must necessarily be somewhat higher than that of ordinary socket and spigot pipes, but the labour of laying and cost of jointing material will be less, and it is hoped that in course of time local authorities may be able to obtain power to enforce the use for house drains, etc., of pipes which will give a concentric joint and true invert, and that the standard Stanford joint may take the place of the old form of joint for all ordinary work. It cannot be disputed that municipal engineers are the largest users of vitrified ware pipes, and the Author would express the hope that the members of this Institution will do all in their power to support the efforts of their own committee to improve the quality of these important materials.

In addition to the work of the sectional committee on sewer and drain pipes, this Institution has representatives on the sectional committees of tramway rails and cast-iron pipes for water, gas, and sewage, and representatives have also recently been appointed to attend a conference to consider the standardisation of road macadam. In addition, representatives of the Institution's standardisation committee have taken an active part in the preparation of a standard specification for street lighting, by a committee called together by the Institution of Electrical Engineers, and composed also of members of the

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Institution of Gas Engineers, and of the Institution of Illuminating Engineers.

The draft specification which contains provisions standardising the unit and method of measurement, classification of streets, tests and testing, etc., has now been completed and will be considered by the Councils of the respective Institutions represented on the committee. Probably, however, the most important work upon which the standardisation committee of this Institution has been engaged—apart from the specification for vitrified ware pipes—is the specification for artificial stone paving. This was first issued about a year ago, and has had a good circulation; in fact, the first edition is now almost exhausted. It deals with materials, moulds, moulding, sizes, samples, tests and testing, maturity, marking, etc. The specification was prepared in consultation with, and received the approval of, the leading makers, and has already been found of considerable value. The Author is aware that the work of the committee has been somewhat freely criticised, apparently in the belief that the matters dealt with have absorbed time and attention of the Council which might have been expended with greater advantage to the members of the Institution upon such subjects as security of tenure and superannuation. He is able to assure members that this impression is quite incorrect. The members of the standardisation committee who have been most devoted to the work of that committee, have been not less devoted to the other work of the Institution, and they submit that the work accomplished by them will prove of value to the members generally and increase the influence of the Institution. Security of tenure and superannuation are undoubtedly matters of vital importance, but they can only be attained by special legislation, and in view of the present congested state of Parliamentary business and to the fact that practically the whole time of the legislature is allocated to Government measures, it is almost hopeless to expect facilities for the introduction and passing of such a measure, even if the Government could be induced to preserve an attitude of benevolent neutrality, which is by no means assured.

In the mean time the Author suggests that anything that can be done for the advancement of municipal engineering and in extending the influence of the Institution must be of advantage to the members, and may in some measure hasten the

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accomplishment of the other objects to which reference has been made. In conclusion, he would urge the members of the Institution to support and assist the standardisation committee in their efforts on behalf of the Institution, both by adopting as far as possible the standard specifications, and by forwarding from time to time suggestions and information likely to be of value to them.

DISCUSSION.

Mr. J. S. Brodie: I have great pleasure in proposing a vote of thanks to Mr. Elford for his paper. I know something from my own experience of the work he has put into this question. He has presided for two years over the committee of the Institution which has had it in hand; I have been a member of that committee myself, and I can bear testimony to his good work therein. Information bearing on the subject has been obtained in many localities, a specification for concrete flags have been out for some months. I took up the matter in my own district, with the result that the makers are working to the specification, and if the Committee had done nothing more than that they would have done very good work. Many other materials appertaining to the work of municipalities we have had under consideration—from vitrified drain pipes to shovels and hammers. I hope the committee will some day standardise all the things that we have occasion to use. It is urged sometimes that standardisation will not be altogether a blessing; that it will lead to lack of enterprise, lack of originality, and all sorts of evils. That is not so. Our standards are not like the laws of the Medes and Persians; if we fix on a standardised form for anything, and any one comes along with an improved form of it, we shall be quite willing to adopt it, and cast our form aside, if a better one can be substituted for it.

Mr. Silcock: I will second that. I quite agree with the suggestion that the members of the Council should from time to time give us some record of the work they have done. I wish to bear testimony to the advantages of standardisation with regard to Portland cement. We have undoubtedly made great advances in the quality of the cement which is supplied now, compared with what we used to have some years ago. With so many specifications it was not worth the manufacturer's while to alter

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the make unless he had a very large order, and the consequence was that sometimes we got cement which was not so good as it should be. Since the standard specification has come into force, however, I have never had a consignment that has not passed all tests. I think that says a great deal for the success of the manufacturers in complying with our requirements. The committee have not yet issued the standard specification for stoneware pipes, but that, I hope, will soon be in force. The suggestion with regard to the modified form of socket, was one which it did not seem to be possible to carry out successfully. It appears to me that all the committee can do in the matter of the socket is to get some form of standard width and depth of joint. Materials should be of uniform quality, and of a certain standard, but it does seem to me that a particular method of jointing should not be standardised, because that would interfere with the enterprise of private individuals, in trying to improve the joints already on the market. The "Stanford" joint mentioned by the Author is a useful thing as a self-centring device, but for making a water-tight joint, I do not think it is of great value. A "Stanford" joint with a deep socket allowing sufficient space for a cement joint to be made in addition, is more likely to be satisfactory, but in cases where water pressure is exceptionally severe, no doubt some other form would be more applicable.

Mr. A. J. Price: I think we all agree that we want standardisation for rails and cement, and the cement specification issued by the committee has been of great assistance. With regard to pipes, I think it is rather a pity that the regulation adopted years ago, of putting a black band round the inferior pipes has dropped out. There was no danger then of those with a black band being mistaken for something else. No doubt it is difficult to get a chemical standard. The fireclay or earthenware pipes made in the Midlands are no doubt greatly improved, because I know in my own district in Lancashire we are getting pipes of the same character which are improved beyond conception compared with the pipes we got some years ago. With regard to the Stanford joint, I am in a district where we are practically water-logged for a great part of the year, and I have always used a Stanford joint in preference to a number of other patent joints which are on the market. As to tests, I test my pipes with water, but I do not like the test of 100 to 125 lbs. per square inch put down here; I do not see the use of it.

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Mr. Elford: That is a stress on the sectional area of the pipe.

Mr. Price: If you were testing pipes in the trench, you would not put that great stress on them. I think myself the Stanford joint practically meets all requirements.

Mr. G. W. Lacey: It seems to me that this is rather a difficult subject, and not at all an easy matter to standardise methods of construction or types in many articles used in constructive work. Take the case of steel rails. These, naturally, are wanted in certain sizes, and it is easy to standardise a certain number of sections, but then there is the composition of the steel to be considered. With regard to pipes, a pipe which is made in one part of the country differs altogether from one which is made in another, and it is not impossible to have many types of pipe on the market, all very good, to be used for different classes of work. The Stanford joint mentioned is a good one for obtaining true alignment, but it is not to be trusted altogether for water-tightness. There are other cases in which standardisation has been very useful: cement, for instance, in which great improvements in methods of manufacture are noticeable. The more one can standardise as to quality the better, but as to constructional methods, it seems rather more difficult of attainment.

Mr. J. S. Pickering: It is stated that the chemical test is impracticable, and that the absorption test is to take its place, I would suggest that there ought to be a test for crushing. A hydraulic test giving the tensile strain would go a long way to prove the quality of the material, but the most practical test of all is the crushing strain.

The President: It is very desirable that road materials should be standardised. There is now a most extraordinary state of things in the engineering world with regard to roads. The word "granite" has become a term covering every kind of hard material—basalt, quartzite, millstone grit, even limestone, are advertised and sold as granite. It is very desirable, therefore, that the petrological description of the stone required should be specified. Another standardisation that we require is the standardisation of gauge. I buy material from a dozen quarries, and there are no two of them which supply material of precisely the same size. They all have their own gauges, and I therefore suggest that it is desirable to standardise road materials petrologically, and also with regard to gauge.

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Mr. Elford, in reply to the vote of thanks, said: I thank you all very sincerely for the remarks you have made. Mr. Price has supported the making of a standard quality of pipes that has been considered by the committee, and a clause dealing with it will be included in the specification. I quite agree that it is an important matter, and I had its importance brought home to me some time ago. When I was using some glazed bricks specified to be of first quality, a sample was submitted and approved. When, however, they were delivered at the works, most of them were marked with a large figure "2." The manufacturer had quite recently decided "to mark all seconds bricks with a large '2'." I need not say the contractor was much surprised. The hydraulic test is for soundness. Mr. Pickering's point as to the inclusion of a crushing test has been very fully discussed by the committee, and they came to the conclusion that it is an unnecessary, troublesome, and expensive test. It is seldom that a pipe fails by the crushing of the material, even with an externally applied load it usually fails in tension, and by applying the hydraulic test you are putting on the structure of the pipe a full evenly distributed tensile stress. The committee came to the conclusion that the hydraulic test is more useful and more easily applied. In regard to the matter of joints, to which Mr. Silcock referred, I should like to say that the committee do not intend to lay down a standard method of jointing. The committee have had brought home to them from many sources the importance of having a joint that will give a large degree of initial concentricity. The object of the committee in suggesting a modified form of joint is not to ensure water-tightness; that is a question of good workmanship. The committee think it is of great importance that there should be a form of joint which without great trouble, or the exercise of any great intelligence on the part of the man engaged in laying the pipes, will give a concentric joint. The joint illustrated in the paper is one of a number of similiar joints taken out of one short length of drain, and gives a good idea of what happens at the present time. Personally, I feel that the committee ought not to standardise the present form of socket. I do not suggest that the Stanford joint is suitable under all conditions, but it is a joint which gives initial concentricity. If something of the kind suggested is done we may be able to get by-laws so amended as to require reasonably concentric joints in house draining. After all, these are the things we

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want to look to, and I hope that in time good joints may be made universal. It is suggested that standardisation leads to stereotyping, but to my mind standardisation should be progressive. If we have a standard which represents the minimum required for good work to-day, it may be necessary later to raise that minimum. It has been done, as you know, in the case of Portland cement. In regard to the absorption test, I have carried out a good many tests, and have come to the conclusion that it is a very desirable one. I had sent by the same maker two different lots of pipes. One gave an absorption of between 8 and 9 per cent., the other an average of 0·38 per cent., an enormous difference. I think that test will be one of the best included in the standard specification.

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THE MAINTENANCE, FLUSHING, AND CLEANSING OF SEWERS IN HAMPSTEAD.

By OLIVER E. WINTER, Assoc.M.Inst.C.E. (*Member*),
Borough Engineer and Surveyor, Hampstead.

The object of the Author in submitting this short Paper to the Institution, is to describe some special features of work recently carried out in the Metropolitan Borough of Hampstead, under his direction as Borough Engineer, in connection with the maintenance, cleansing, and flushing of the sewers in the borough. Hampstead drains into the Metropolitan Drainage System, and there are about four miles of main trunk sewers under the control of the London County Council in the borough. There are 60 miles of sewers under the control of the borough council, of which 35 miles are brick and 25 miles are pipe sewers. The sewers take both sewage and storm water. The gradients are generally good throughout the borough; the surface varying between 100·1 and 441·3 above Ordnance datum.

1. *Maintenance.*—Many of the older brick sewers, constructed between forty and fifty years ago, have in recent years become defective, calling for considerable repair or reconstruction. The chief defects are generally in the invert—which has been mostly constructed in brickwork in cement blocks or cases. This has become worn, with settlements in places. The side walls and arch of sewer have been built of good hard bricks, but with wide joints, in lime and, often, burnt ballast mortar. The brickwork has consequently become uneven, with rough surface, and impossible to keep in clean condition. The brick sewers are egg-shaped, the usual sizes being 3 feet 9 inches by 2 feet 3 inches and 3 feet by 2 feet. In many cases these sewers are much larger than required, and where extensive repairs are required, it is necessary to decide, first, as to the advisability of reducing the size of the sewer, and reconstructing in a glazed

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stoneware pipe sewer of sufficient size so as to be self-cleansing, or of carrying out repairs and renewals to the old sewer, if material reduction in size is impracticable. A good and somewhat unusual example of the first method is a reconstruction, which has been carried out to a 3-feet by 2-feet brick sewer, passing under the West Heath, including the "Leg of Mutton" Pond, and draining the portion of the borough known as "North End." This sewer was constructed forty-seven years ago, and it is stated that considerable difficulties attended its construction, owing to the running sand and water. The side walls and arch in places were being pressed in, and water and sand were being forced through the rough joints of the brickwork by the outer pressure. There appeared to be serious risk of the collapse of the sewer. After careful consideration and experiment the Author advised the construction of a 15-inch pipe sewer, within the old 3-feet by 2-feet brick sewer, and filling around the new pipe solidly with concrete. Although the space available for working in the old sewer was very confined, the work has been carried out and completed in a sound and watertight manner, working from the existing manholes, and the shafts for the new manholes, it was desirable to construct. Otherwise, any further opening in the difficult ground was avoided.

The stoneware pipe adopted for the work was the grouted composite jointed pipe, manufactured by Messrs. Doulton and Company. It was necessary that a joint should be used which could be easily and quickly made in running water, and thus avoid any diversion of the running sewage. On inserting the spigot into the socket, the composition rings (which are previously greased) at once form a sound joint. The attached canvas casing (or bag) allows the cement joint to be easily made. When the cement grout is poured into the canvas casing, any water within the casing is driven out through the canvas by the heavier grout, and a perfect cement joint is secured. In laying the new pipes, it was desirable they should be laid to a true gradient between manholes. As the old sewer had settlements in places, it required considerable care in fixing the new levels. This was done in the following manner:—The level of the new invert was fixed at each manhole; 2-inch by ¾-inch wooden battens were fixed on each of the side walls, at the required level, by a boning line from manhole to manhole. Gauge is then worked from the under side of the batten to the invert of the pipe, and the pipe-layers

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can easily work to a true line, whatever the gradient may be. Periodically, when the flow of sewage was at the minimum, the sewage was dammed back, and a water test of 25 feet to 35 feet head was applied to lengths of pipes laid, varying from 20 feet to 30 feet. These tests showed that the joints were quite water-tight, notwithstanding that the pipes were laid in water varying from one-third to three-quarters the diameter of the pipe. After the test mentioned, the whole space between the pipes and the old brickwork was filled in with cement concrete. The length of sewer dealt with in this manner was 2806 feet. The estimated cost of this work, including new manholes, abolishing two very objectionable stepped ramps, and constructing in iron pipes in the form of tumbling bays, amounted to 2300*l.* The actual cost of the work, carried out by the Council's staff, has amounted to 2234*l.* A loan was obtained from the London County Council for this amount, to be repaid in twenty years. An excellent self-cleansing sewer has thus been obtained in substitution for a defective and offensive brick sewer, for about one-fourth the cost of the original sewer. The actual cost of the 15-inch pipe sewer work alone, including filling in to the old 3-feet by 2-feet sewer, worked out at about 9*s.* 6*d.* per foot run, complete. The same method has been adopted with other defective brick sewers, the same jointed pipe being used in each case as last described, but of the diameter to meet the needs of each case. The following particulars may be given of these:—

Size of Old Sewer.	Diameter of New Pipe.	Cost per foot run complete.
3 feet 9 inches by 2 feet 6 inches.	9-inch.	10*s.*
3 feet 6 inches by 2 feet 3 inches.	12-inch.	8*s.* 9*d.*

The following data may be useful in connection with this work:—

Fifteen-inch stoneware pipe in 3-feet by 2-feet sewer: one pipe-layer and three labourers laid and completed, including concrete filling, on an average 5 feet per day.

Twelve-inch stoneware pipe in 3 feet 6 inches by 2 feet 3 inches sewer: one pipe-layer and three labourers laid and completed on an average 9 feet per day.

Nine-inch stoneware pipe in 4 feet by 2 feet 8 inches sewer: one pipe-layer and three labourers laid and completed on an average 12½ feet per day.

In cases of old brick sewers, where it has not been practicable

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to reduce to much extent the size of the sewer as last described, a different method must be adopted. As already stated, the chief defects to be remedied were in the invert. But the brick inverts are not generally so defective as to require entire underpinning, nor the complete removal of the inner ring. To meet such cases, the Author designed a reinforced concrete invert, to fit the existing invert of the sewer. The invert was made to the section shown on the drawing, 2 inches in thickness, and in lengths of 2 feet, with rebated joint. Of this size, they could be readily handled, and got into the sewer through the existing manholes or side-entrances. The inverts are made by the Imperial Stone Company of Tottenham, and usually stored three or four months to permit them to thoroughly harden before being sent to the works. The concrete inverts were bedded and jointed in cement mortar, and where any depressions existed in the old invert, or more regular falls could be obtained, on fine cement concrete. To firmly secure the inverts in position, over each joint a corbel, 4½ inches by 6 inches by 2¾ inches, was pinned into the side walls of the sewer. A cement benching was formed on the top of the invert, enclosing the corbels, and making one finished continuous line. The inverts were lowered into the sewer in a rough frame to prevent damage, and placed on a specially made trolley, and conveyed to the point required. During the time the inverts were being fixed in position the sewer was dammed up, and the flow conducted along the side walls in galvanised iron troughs, arranged sufficiently low to receive the drainage from the house connections. Several thousand feet run of this invert has now been fixed in such old brick sewers as described, with very satisfactory results. The cost of the new invert, including bedding and laying complete, averages from 4*s.* to 4*s.* 2*d.* per foot run. This is a much lower cost than would have been incurred in cutting out 4½ inches of the defective brick invert, and renewing in brickwork. The sides and crown of the sewer were scraped and thoroughly washed; the joints of side walls raked out about 1½ inches deep, and filled in and repointed with cement and sand mortar (one and one). In a 3 feet 9 inches by 2 feet 3 inches sewer, the cost of this work varied from 2*s.* to 3*s.* per foot run of sewer, according to the amount of defective brickwork requiring to be cut out and made good. The total cost, therefore, of putting these old sewers into a thoroughly good and sound state of repair, did not

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exceed 6*s.* to 7*s.* per foot run. Good clean sanitary conditions have thus been obtained at a comparatively small expenditure. After these works have been completed, there has been a very marked improvement in the air within the sewers, which cannot fail to have an important beneficial effect on the general sanitary condition of the neighbourhood.

2. *Flushing and Cleansing.*—Regular and systematic flushing of sewers is of great importance, and absolutely necessary in keeping the sewers in a clean condition, and free from nuisance. For this work in Hampstead, the borough is divided into three districts, and six men are regularly engaged—two in each district. There are forty-two flushing tanks constructed underground, with a capacity of about 2000 gallons, which are discharged at least once a week. Water is supplied through a meter, from the Metropolitan Water Board's mains. These tanks are arranged at such points that they can flush two, three, or more sewers—by means of flaps. The flushers who attend to their working, also clean out the surface ventilators, and see that all gully gratings in their respective districts are free from obstruction, and report any defects. Flushing manholes are also arranged at the apices of other lengths of sewers, and are flushed out from time to time as circumstances require, by a steam motor watering and flushing van of 1000 gallons. This van has proved very efficient for the purpose. A gang of not less than three men traverse all the brick sewers, for the purpose of removing any deposits. They also see that the flaps to house drains are working freely.

Where large brick sewers exist, and especially where such sewers are only at long intervals fully charged in times of exceptional rainfall, it is desirable that further cleansing should be carried out, in addition to the regular flushing. The Author's attention was called to this very forcibly in a report on sewer ventilation made to the Hampstead Borough Council in 1905, by Dr. F. W. Andrewes and Dr. W. H. Hurtley, after a careful examination of the older brick sewers. They state :

"It is probable that much, if not all, of the smell arising from the ventilating grids depends not on emanations from the flowing sewage, but on decomposing organic matter and fungoid growths on the walls of the sewers, which are in some places in an exceedingly filthy condition. We were informed that when the men employed in the sewers had to work for any length of

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time in one place, they did, of their own accord, wash down the, walls for some distance from where they were working, and that this expedient considerably reduced the offensiveness of the air. We therefore recommend that where nuisance arises from the sewer grids the walls of the whole sewer in question should be thoroughly washed and cleaned and finally rinsed over and otherwise treated with a disinfectant. Should it be found, on trial, that the nuisance can thus be abated, the cleansing should be carried out as far as possible throughout the district, attention being especially paid to the older brick sewers."

For the purpose of thoroughly cleansing brick sewers, the Author has devised an arrangement of a portable meter with hose pipes. The portable meter is attached to a street hydrant and a 2½-inch hose pipe is conducted from the meter to a side entrance or manhole. An attachment is fitted at the end of the 2½-inch hose pipe, with two valves and smaller hose pipes, each controlled separately, and arranged so as to work up or down the sewer. Four men are employed in the sewer, two at each end of the smaller hose pipe, one spraying the water on the walls, the other scrubbing with a bass and steel brush. Two men are required on the surface or near the entrances to manipulate or guard the hose pipes. The Water Board insist upon having a waterman in attendance while the meter is working, and a charge of 6*d*. per hour is made. The cost of such cleansing, including water and labour, works out at about 1½*d*. per foot run for a 3 feet 9 inches by 2 feet 6 inches brick sewer. There has been a very marked improvement in the air of a sewer after this cleansing has been carried out, and there can be no doubt as to the desirability, from a sanitary point of view, of such cleansing from time to time, as occasion requires.

The work described in this brief paper is not so striking or sensational in character, compared with other work carried out by a municipal engineer, and it is almost entirely hidden from the public eye. Such work may add little or nothing, for the moment, to the reputation or credit of the official responsible for advising thereon, and carrying out the work in a sound and satisfactory manner. But in conscientiously and energetically discharging his important duties in connection with the maintenance of the drainage system under his control, in a clean and sanitary condition, he very quickly sees substantial beneficial results accruing to the public he serves.

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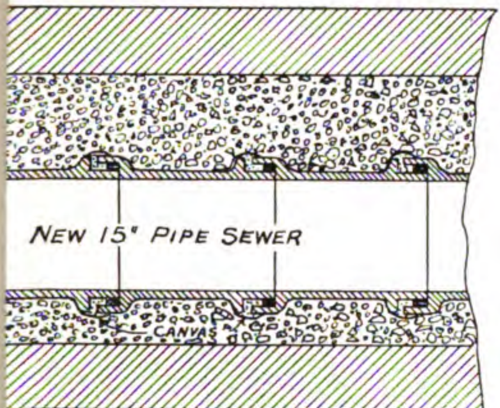
SEWERS.

IPROVEMENTS.



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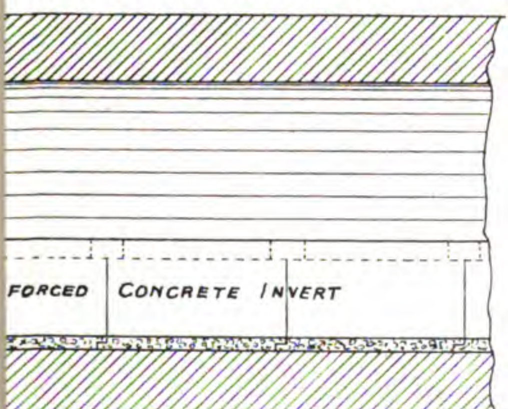

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DISCUSSION.

MR. E. J. SILCOCK: I move a vote of thanks to Mr. Winter for his paper. In doing so I would call attention to the particular value of this paper; inasmuch as it gives us information as to the life of sewers, a matter which frequently turns up when discussing the length of the term for which loans are to be granted for the construction of works. The length of a loan period naturally should be regulated by the life of the works. Thirty years, which is the maximum term allowed by the Local Government Board, seems all too short for works such as sewers which undoubtedly, if well constructed, have a much longer life than 30 years. Here we have a record of sewers constructed 40 or 50 years ago, and reading between the lines, I think we may infer that the sewers, as first constructed, were not made of the best class of materials, or with the best class of workmanship. Being in the London District, I think we may assume the bricks would not be so good as Staffordshire blues, or as the engineering bricks which can be obtained in many districts to-day. The joints also were of inferior material to those of to-day. Under these circumstances it would seem that the life of the sewers of Hampstead has already been considerably over 30 years, and that now, with a comparatively small expenditure, that life will be considerably extended. With regard to the system adopted by Mr. Winter of putting a pipe sewer inside a brick sewer, it cannot be adopted often, on account of considerations of size. I gather that the sewers in this case were considerably larger when first constructed than was necessary, but even so, the placing of a 15-inch pipe sewer inside a 3 feet 9 inch brick sewer must have required a special type of man—smaller than the ordinary navvy. This applies particularly to the work of concreting round the pipe. The Author tells us the work was done in lengths of twenty or thirty feet; certainly there could not have been very much room for a man to get in to work. The system of jointing for stoneware pipes referred to is one of which I have had considerable experience, and I should like to confirm the statement that it is a very satisfactory method of jointing, especially when water is running through the pipes during the time the joint is being made. The only thing that strikes one is that the test applied to the pipes seems to be unnecessarily severe, and I doubt whether under working

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conditions it is wise to put such high pressure on the inside of the pipes.

MR. E. J. ELFORD: I second the vote of thanks. I do not quite understand how the concrete inverts are reinforced, nor do I quite see the value of reinforcement, having regard to the conditions under which they were used. Mr. Winter refers to tanks for flushing the sewers. It would be interesting if he could give us some figures as to the cost of these fixed flushing tanks, as apparently this is a considerable sum.

MR. J. S. BRODIE: This is a very interesting paper, and it would have been still more interesting if Mr. Winter had given us in a little more detail the defects he found in the brick sewers. I take it that the chief defects would be the inferior mortar joints and brick settlements. It is always interesting, when you have to substitute new sewers for old ones, to know in what respect the old have failed, and then you can tabulate the information. One peculiar thing is the large size of the old sewer as compared with the new one. Either the old sewer must have been too large, or the new one must be rather too small. In regard to flushing tanks, I do not think there is much to be said against them; the only difficulty is the quantity of water that is required to make them really effective. It is not every town that is so well off as Blackpool, where we have both a fair supply of fresh water and an unlimited supply of salt water. The length of time allowed for repayment of loans in regard to sewers has been alluded to. There seems to be a feeling in some quarters that sewers, once put down, are there for ever. We who are in charge of these matters know that is not the case. The time does come when the best work shows defects, and has to be made good. The loan period should not, I think, be a very long one; that is to say, it should be calculated on the probable length of life of the work, but not on the convenience of the authority with regard to the repayment of the loan. I have known some cases of sewerage works where sixty years was granted, and I think that is too long. If it were cut down by one half, or even to a still shorter period, it would do away with the temptation to local authorities to go in for an enormous capital expenditure because the annual payments are so small.

MR. E. WILLIS: When I was at Willesden there was a case of a somewhat similar character. A certain sewer was subjected to heavy pressure from traffic at the time of the great exhibition,

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and it did not stand it as it should. We found that instead of the inverts wearing, the haunches were pushed in. We found the sewer was about one foot four inches in width in places, and in some parts the road was resting on an open cavity due to the haunch being pushed in more than the thickness of the brickwork. This was cut out in short sections; fortunately there was not a large flow of sewage along it. The work was perfectly done, but it took a good deal of time. I do not, however, think the expense came out at quite so much as in Mr. Winter's case. I have this morning left a similar piece of work, where the sewer was constructed prior to 1861. I had had it under observation, as signs of trouble have been apparent for some time past. About a fortnight ago I opened up where I anticipated the worst trouble, and found that a cavity had formed, 6 feet 9 inches, by 4 feet 6 inches, by 8 feet deep, into which a horse might easily have fallen and disappeared entirely. I could not at a moment's notice get the Council to undertake remaking entirely, but by careful repair I was able to prevent any accident. It did occur to me that, as space was limited, it might have been difficult to concrete in 30-feet lengths, and I was going to ask Mr. Winter if it was possible for a man to joint up as he carried the pipes along. When I have had somewhat similar works, I have always had the jointing done as we progressed, and by this means I have been able to give the men a fair amount of room to work in. I have used the same joint that Mr. Winter used with marked success. The cost does not appear to be excessive, and the Author is to be complimented on the length he was able to keep going per day. The scraping sewers as described may be very useful in certain cases. I should like to have a little more information on flushing if available, as I have had experience of both flushing tanks and flushing vans. I have also tried to deal with the Water Board on the question of the turncock for flushing barrows with portable metres, and to induce them to trust to the honesty of the engineers who are in charge of such work. In conclusion, I wish to support the vote of thanks.

Mr. S. E. Burgess: I should like to know what provision was made for rainfall in these small sewers—is it one-third or one-quarter of an inch per hour?—from the particular drainage areas served by the respective sewers.

Mr. Matthews: I should like to ask whether in this first section of the brick sewer they are not likely to find great

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difficulty in connecting house drains? With regard to the bottom section, with the reinforced concrete invert, I do not see the need for reinforced concrete in a position of this kind. I should have thought that an ordinary cement invert would have been quite satisfactory. With regard to automatic flushing tanks, I have fourteen tanks at Bridlington, and have never had any difficulty with them. I know that in some towns difficulty has been experienced, but I have had none. So far as the water committee are concerned, they rely entirely on the figures I give them of the number of gallons of water used yearly in the tanks; we pay for the water used at the rate of 6*d.* per thousand gallons. At the height of the season we let the tanks go off twice a day on two days each week, and we find this flushing very effective indeed. I desire to thank the Author for his instructive paper.

MR. HARPUR: I have a great many automatic flushing tanks at Cardiff—if I said a hundred I should not be far from the mark—and I never had any difficulty in working them. There is a water meter attached to each one, so there is no question about measuring the quantity of water used. We can turn on the supply at any time it is desirable to do so; and so regulate the supply that the tank will discharge as frequently as may be deemed necessary, and we have found that this method of flushing does an immense amount of good. If tanks are constructed on those lines there should be no difficulty of any kind.

THE PRESIDENT: It is from the results of wear, and the actual conditions of old work, that we learn very largely what to avoid and what to continue doing. The more we get from experience in actual working, the better we shall be enabled to carry out work in the future.

MR. WINTER: I beg to thank all those who have taken part in the discussion. As to the precise condition of the old brick sewer, the bricks were of fairly good and sound quality. The defects were mainly in the jointing, very inferior mortar having been used. The chief defects were in the invert, where the joints were open, making them receptacles for filth, and they had settled in places, so it was a question of putting in a new invert of blue brick or dealing with it on the lines described in the paper. If I had adopted blue brick the invert would have been improved, but the cost would have been increased, and the general result would not have been so good as that I have obtained. With regard to laying the 15-inch pipe in the sewer,

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perhaps I have not made it sufficiently clear that two or three pipes were laid at a time and concreted as the testing was carried out. It would, of course, have been impossible to make the concrete good except as the pipes were laid. The reinforcement was of a slight character, stout steel wires placed in sections in the moulds as the concrete was manufactured. I think the reinforcement is useful. The thickness is only 2 inches, and the extra cost is small. I have no exact figures as to the comparative cost of flushing by motor vans and by tanks, but I am pleased with the result obtained from the tanks. The payment for water in London for this purpose was 6*d*. per 1000 gallons. The connection of house drains where the pipe sewer is put into the brick sewer added to the cost, but we had no difficulty in the work.

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SUGGESTIONS TOWARDS A STANDARD SPECIFICATION FOR BITUMINOUS-BOUND CARRIAGEWAYS.

By JOHN S. BRODIE, M.Inst.C.E. (*Member*), Borough Surveyor, Blackpool.

Two most successful papers were read and discussed in another place a year ago by two of our esteemed members, viz. Mr. J. Walker Smith and Mr. Henry Percy Maybury, MM.Inst.C.E., on highway construction and maintenance. At the same time the Road Board issued general directions and specifications (Nos. 1 to 6) relating to the tar treatment of roads. Both of these events were of the utmost importance to all who are engaged in the responsible duties of road surveyors, and the Author was one of those who gladly availed himself of the information contained in the papers, and of the directions and specifications contained in the Road Board's issue, in revising his specifications both for new roads, as well as for reconstructing and resurfacing existing roads in his district.

The following clauses and suggestions are submitted as a basis of discussion, in the hope that they may be found useful to surveyors having the responsibility for similar works, until a more complete experimental knowledge of the properties of materials suitable for roadmaking is available, as it must be obvious to all that we are really at the beginning only of a sound and reliable appreciation of the various materials which should be used in road construction and maintenance so as to obtain the best economical results. In this connection it is with very great pleasure that we note the steps which it is understood are now being taken by the Road Board to accurately test, classify, and standardise materials and processes which may be found successful in road construction. It is the Author's practice to carry out road construction both departmentally, and also by expert road constructors working under contracts to construct certain lengths of roads

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to a specification, and to subsequently maintain the same for a certain number of years (usually five years) under financial guarantees.

Further, the Author does not confine his invitations for tenders for work in accordance with his own specification only, but he also invites skilled and experienced road constructors to submit alternative general specifications prepared by themselves, including any proprietary articles, or special or patented processes with which their methods of construction may be associated; subject of course to guarantees for successful completion and maintenance for a period of years; the object being to secure the best possible results obtainable for a given financial expenditure.

It is of course obvious that, however desirable it may be to standardise our road specifications, regard must always be had to local and other conditions requiring special consideration and treatment. No hard-and-fast lines can be laid down applicable to roads in every part of the country, or indeed to every part of the same district. Thus, roads running east and west will require somewhat different treatment to those running north and south, as well as roads closely hemmed in by trees to those in open country. The nature of the subsoil, the gradients, the rainfall, the direction of the prevailing winds, and above all, the suitability or otherwise of the local materials of construction and maintenance will all require most careful consideration if the best results are to be attained. The nature and amount of traffic likely to pass over the road is one of the first things to be ascertained. Much attention has been recently given to this important subject, both in this country and in the United States.

The elaborate and accurate methods of enumerating traffic on highways, as exemplified by one of our esteemed Members, Mr. William Jones, Assoc.M.Inst.C.E., surveyor to Colwyn Bay Urban District Council; by Messrs. Blanchard and Patterson, of Providence, R.I.; and by Major Crosby, chief engineer to the States Roads Commission of Maryland, M.S., all of which have been reported in "The Surveyor," are worthy of all praise for their painstaking accuracy. Although there is at present some difference of opinion in regard to the relative importance of the different kinds of traffic so far as the maintenance of the road is concerned, there is no doubt but that surveyors will sooner or later agree on a standardised system of enumerating traffic.

The Author does not at present propose to further discuss

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this interesting subject, but will assume that traffic data having been ascertained with more or less accuracy, it remains to express it in terms which will find common acceptance. Thus, instead of one surveyor expressing his traffic intensity in tons per day and another in tons per week, the Author urges that traffic be always expressed in *tons per annum per lineal yard of width of roadway*. Further, the Author suggests that, for convenience, a "scale of traffic intensity" be agreed upon, on somewhat similar lines to the "scale of hardness" for water, or minerals, ranging from a minimum of 10,000 tons per lineal yard of width of road per annum to, say, a maximum of 300,000 tons, with intervals of 10,000 tons. The suggested scale would, therefore, be "traffic intensity 10, 20, 30, 40, up to 300," and its meaning would be both definite and easily understood.

Suggested clauses to be included in a specification for a bituminous-bound carriageway.

1. *General.*—The carriageway is lineal yards in length, lineal feet in width, and has an area of square yards: it is bounded on both sides by stone kerbing (or wayside ditches or channels); its general direction east and west (or north and south or any nearer definition); the gradients are from 1 in to 1 in ; the traffic intensity is (say) 50; it is closely shaded by trees on one (or both) sides (or is open); the subsoil is ; the prevailing direction of the wind is ; the stone available within miles is ; tar can be obtained at a distance of ; and the nearest railway goods depôt is at a distance of .

2. *Period for Construction.*—The work of construction will be carried out during a period of weeks from (say) January to (say) April; and the traffic will be partially (or wholly) suspended while the work is in progress.

3. *Sub-foundation.*—The contractor must excavate or fill in the site of the road, so as to form the underbed to the proper levels and contour of the foundation, and shall thoroughly water and roll with a 10-ton steam roller before laying the hand-packed rubble hereinafter specified.

One or more longitudinal subsoil drains must be laid, if required, where the subsoil is of an impervious nature, such as clay, peat, or other water-carrying material. Such drains shall consist of butt-ended drain tiles 3 inches in diameter, laid in trenches 2 feet 6 inches in depth, and must be connected to the

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road gulleys or channels. After the tiles are laid, the trenches shall be filled up with sand, gravel, or other open or porous material.

4. *Foundation.*—The foundation shall consist of hand-packed rubble stone, preferably of sandstone, carefully selected. The stone must not be less than 7 inches in depth, from 5 inches to 9 inches in length, and from 3 inches to 6 inches in width, laid on edge, the stones being laid lengthwise across the roadway, to the finished profile. The interstices of the pitching must be thoroughly "blinded" up with any of the following material, viz.,—broken concrete, broken sandstone, or specially hand-picked clinker. The whole must then be thoroughly watered and rolled with a 10-ton steam roller; afterwards the larger pieces of packing must be picked out, rebroken, respread, and watered, and rolled again to the proper profile. This process must be repeated until the surface presents the appearance of a well-rolled macadam road. The depth of the foundation when the rolling is completed must be not less than 7 inches. No tar macadam must be laid until the foundation has been inspected and approved by the surveyor or his assistant or inspector.

5. *Stone for Tar Macadam.*—The tar asphalte macadam shall be made with white or gray coloured limestone, or other stone from a quarry to be approved by the surveyor. The stone shall be broken and gauged to three sizes, viz. not less than 60 per cent. to $2\frac{1}{2}$ inches, not more than 30 per cent. from $2\frac{1}{2}$ inches to $1\frac{1}{2}$ inch, and 10 per cent. to $\frac{3}{4}$ inch to $\frac{1}{2}$ inch, all below $\frac{1}{2}$ inch being discarded.

6. *Quality of Tar, Pitch, and Tar Oil.*—The tar, pitch, and tar oil proposed to be used shall be in strict conformity with the Road Board specifications Nos. 5 and 6, for tar No. 2, pitch, and tar oil, copy of which is attached hereto, and samples shall be taken by the surveyor before the work is commenced and submitted by him to a qualified analytical chemist, for testing in accordance with the specifications above referred to.

7. *Drying and Mixing.*—The whole of the broken stone must be thoroughly dried, all dust removed, and heated to about 220° Fah. before being covered with the tar, and the mixing must be done under cover. There shall be used from 9 to 12 gallons of tar to one ton of broken stone, the tar be applied to the broken stone at a temperature of from 260° to 280° Fah. as taken in the tar boiler. Mixing must be carried out by an approved

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mechanical power asphalte mixer, while the stone is dry and heated, and shall be treated until the entire surface of every stone is covered with tar.

8. *Laying.*—The respective sizes of broken stone, immediately after mixing with the tar, shall be spread, levelled, and rolled, with a 10-ton steam roller, in separate layers; the $2\frac{1}{2}$-inch stone as a bottom layer, and the intermediate layer of $1\frac{1}{2}$ inch in thickness, with a top dressing of $\frac{1}{2}$-inch chippings, the total thickness being, on all parts of the surface of the road, not less than $4\frac{1}{4}$ inches thick, after the rolling is completed and the surface brought up to the required contour.

9. *Tarring and Gritting.*—Within two months of the carriageway being complete as above and used by the traffic, the surface shall be carefully cleansed, and afterwards sprayed with boiling tar as specified, and gritted with granite chippings from an approved quarry gauged between $\frac{1}{4}$-inch and $\frac{1}{16}$-inch square meshed screens, to the extent of 1 ton of chippings to 300 to 350 square yards of surface of road.

DISCUSSION.

MR. E. J. ELFORD: I cordially move a vote of thanks to Mr. Brodie for his paper. There is certainly much to be said in favour of a standard scale of traffic intensity, and no doubt the matter will be dealt with by the Standards Committee. The suggested first-class standard specification is perhaps a little dangerous in some respects, for a number of items of information must be based on individual opinion, and I think it is better to leave more to the judgment of the contractor. If you attempt to give definite information on such points you provide the unscrupulous with opportunities for making a good deal of trouble. In regard to the sub-foundation, while it may be useful with some subsoils to roll the foundation first, there are others, such as clay, which it could be dangerous to so treat. In regard to the stone for tar macadam, I disagree with the suggestion that limestone should be generally employed. It is difficult to get limestone that would carry the steam roller. With regard to laying the material, my opinion is that instead of laying the different sizes in separate layers each of one gauge, it is much better to use material of properly proportioned mixed gauges. I would suggest, too, with reference to the subsequent surface tarring and gritting,

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that instead of requiring this to be done within two months of the completion of the carriageway as suggested, it would be better to specify that the surface dressing shall take place after two months, but within four months. My experience is that a tar-mac road, in the first two months of its existence closes up under traffic, and it is very undesirable to start dressing the surface of a road until the material has thoroughly settled down.

MR. A. J. PRICE: I am pleased to second the vote of thanks. I cannot help thinking that the roads Mr. Brodie has at Blackpool are not all being carried out according to the specification which he has laid down in his paper. The roads themselves are very good roads—the road on the front is one of the finest in the country—but at the same time I do not think they are all laid down according to this specification. As to the question of rolling the foundation, to which Mr. Elford alluded, to roll would be an impossibility for me in a great part of my district, and the same conditions obtain in Blackpool. There are places, indeed, where we should be running a risk of losing the roller altogether; if you put a 10-ton roller on sand or peat, or on the clay there in such weather as we have had during the last few months, I do not know whether you would ever get it out. Very few people will roll a sub-foundation unless they put something on it to level it up. I think the specification is a little too general in that respect. Then, again, with regard to the period of construction. Mr. Brodie suggests January to April, I do not know why. In seaside towns we try to get all we can done outside the season; but I would do no tar-macadam work between January and April if I could help it. When we have private street works, of course we have to do it practically all the year round; but we want warm fine weather for it, because then we can do a better job. With regard to the watering of the foundation, I have had to make about eighty new streets since I have been in Lytham, and of course Mr. Brodie has had a great number more, but to water the foundation is a thing I have never done. I use hand-packed sandstone for a rubble foundation, and if I am going to have tar-mac on the top of that I do not see the necessity of watering. Sandstone is what Mr. Brodie uses largely, and I do not see that there is any necessity to water it. It is not necessary that sandstone should be always used. I would not use it in a district where I could get granite as cheaply, or blue limestone which is as good as most sandstone. I do not see why

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limestone should not be used for a foundation. There are many limestones which are very difficult to tell from granite, and blue limestone in particular is as hard and dense as many granites, or so-called granites. With regard to rolling, I have been trying to get my committee to go in for a small motor roller on these grounds. In one part of my district the sewers are not very deep, and though all the sewers are surrounded with concrete, I am not very sure that a 10-ton roller on these streets would not damage the sewers. I think the road on the front at Blackpool, which is one of the finest in the country, was very largely done with a 4-ton roller.

Mr. Brodie: Both a 4-ton roller and a 10-ton.

Mr. Price: With regard to the quality of tar, if I were to suggest getting all my tar through a chemist, I think my authority would give me the order of the "sack." I get my tar from the gasworks, which adjourn my store yard, and I have to take the tar as I get it. It is very good tar on the whole; still, there are times when we get a good drop of water with the tar. It is all very well to lay down rules and regulations, but they have to be used with discretion, and there are times when it is better to break rules than to carry them out. What I mean is this, there is some tar which you might use on a road which is exposed to the sun and a good deal of traffic on it, but you would not use that kind in a back street where there was neither sun nor much traffic. The tar you use in a street where traffic is heavy and the sun is strong wants to be more of a pitchy nature than that which you use in a back street where there is little traffic. You cannot altogether eliminate the personal factor even if you get standard tar, and it is the same with tar painting. There are places where I use more raw tar than distilled, but generally speaking I use all distilled tar; I never use pitch if I can avoid it. Now we come to the question of drying and mixing stone. I dry as little as I can artificially. I have a dryer in my yard, but I put as little on that as I can. I prefer to place it so as to let the sun get at it, because that is much more economical, and also because if you put stone on a dryer it is very liable to get too hot, and convert the tar into pitch. As to finishing the road and tarring and gritting within two months, I cannot quite see the necessity for that. I do not expect any of the contractors who come to my district to do it; I expect them to make a road of materials which will face easily. I have done a good bit of

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granite tar-macadam work, and I find granite does not take the tar quite so easily as limestone. For heavy traffic I do not care to use limestone; it is very apt to make a dusty road. Granite, on the other hand, will practically carry traffic without any watering at all. I have a main road which has been tar painted, and the watering cart is never put on it from one year's end to another, and it is the road on which most of the motor traffic goes through Lytham from Preston to Blackpool.

Mr. E. Willis: The Author of this paper suggests that contractors should have opportunities for dealing with certain matters in other ways than those which he has specified. I have adopted this principle in practice, not only in reference to tar-macadam but in other kinds of work. It gives the contractors more interest in their work, and puts them on their mettle. With regard to a standardised system of enumerating traffic, that is a thing which we should all like to have, and the standards committee should deal with that better than the municipal engineers or the public in general. I am sorry to differ with Mr. Elford as to Clause I. of the general draft specification, but I quite agree with giving the contractor information which is definite and certain. We all know that in every contract there must be certain conditions affecting it; by all means give those conditions, and then every one stands on the same footing. I do not think any surveyor round London can give definite information with regard to foundations of roads. I have been content with any suitable materials I have had in hand, and I have found a vitrified foundation of broken brick give good results. But the foundation of roads should be largely subject to discretion. I have had experience of a long arbitration with regard to a foundation, and I am glad to say that my Council came out successfully. A heavy extra was charged by the contractor, and my argument was that the cavity of the foundation should be of a specified depth; otherwise the contractor was not definitely putting in the specified quantity of material. The contractor, on the other hand, claimed that he was entitled to make his own allowance; so he allowed from two and a half to three inches over the whole area of the road, only excavating to that depth. The point was argued in the arbitration, and the arbitrator decided to have sections taken over the whole road. My argument was upheld in the long run, and my Council saved a matter of 400*l*. I have also experimented with

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clinker, and have found tarred clinker successful for light traffic roads, especially when treated on the top with fine granite chips. It has been very successful in parts of Beckenham. The important point is that the clinker rolls down to a greater extent than ordinary limestone or granite.

MR. A. E. PRESCOTT: I submit that it is not possible to standardise any system of road making at the present time. Standardisation of material may be necessary and effectual, but each authority must be guided by its own local conditions, therefore it is not possible to standardise, as a whole, the system of road-making. I agree with Mr. Brodie that it depends largely upon local conditions and circumstances, and each surveyor must be guided accordingly. There are, however, one or two points in the paper on which I am not quite in harmony with Mr. Brodie. . One point was mentioned by Mr. Price with regard to the use of the 10-ton steam roller on tar macadam roads; I am of opinion that a much lighter roller is more effectual, as it does not tend to press the tar macadam in front of it in a series of waves, but, on the other hand, tends to solidify the material, and obtains cohesion without any disturbance of the material. The method I have adopted is to use a hand roller after the material has been spread, in order to obtain a slight amount of cohesion and solidity, after which a steam roller is allowed to roll over the whole surface, and this method appears to answer well, and satisfactory results are obtained. I am also strongly of opinion that the top coat of a tar macadam road should be composed of material of a fine gauge, in order to obtain a perfect seal, and an impervious surface. I have been much interested in the remarks with regard to the use of clinker for tar macadam roads. I cannot say that I have yet adopted this method, as I am of opinion that it is quite unsuitable. It may, however, be found satisfactory for secondary roads, or roads which are subject to scarcely any traffic, but I cannot conceive that material of this nature can give permanently satisfactory results. A curious feature with regard to the use of tarred clinker is the residue of nails and other similar material which cannot be removed from the clinker during the process of tarring, the result being, that these nails find their way to the road surface, and in one instance a Member of this Institution informed me that for several years after the tarred clinker had been laid it was possible any morning to sweep up a large quantity of nails which appeared to come

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up like mushrooms in the night. It would, however, be interesting to hear whether this is the experience of other Members who have experimented with this material. I have much pleasure in supporting the vote of thanks to Mr. Brodie for his very excellent and interesting paper.

Mr. Blair: I have taken a good many observations of traffic, and I think we should be able to work under one uniform method. To reduce the figures actually taken to a certain rate per annum is misleading. Mr. Brodie proposes that traffic be always expressed in tons per annum per yard of width of roadway. Most of us are content to take traffic records over a period not longer than seven days, and many take traffic on one day in one season, on another day in another season, and to calculate that into traffic per annum would convey no more than if we had recorded it per yard or per foot per day of eight hours. From my experience you get nearly the whole of the traffic between 8 a.m. and 8 p.m. That, of course, may not be accurate in special circumstances; for instance, you get in London a heavy night traffic to the terminal stations, and in such cases it may be necessary to take the traffic for twenty-four hours. Should the night traffic equal the day traffic, it might be reduced to tons per foot in width per hour. I think, however, that we shall get accurate results if we take the traffic from 8 a.m. to 8 p.m., and reduce it to tons per foot of width of road. We shall then be able to compare one street with another, and one district with another. Another important distinction is that between rubber-tyred traffic, and iron-tyred traffic. I told you last year that I had two tar macadam roads, and that one of them was a failure and the other a success. We have had another twelve months' traffic on the success, and it is still a success. After another twelve months that road is still perfect, carrying a traffic of over six hundred vehicles per hour. It is the approach road to Euston station, and it ran great risk of being spoiled, as it was made in showery weather.

Mr. W. Jones: The sheets on which the records of the traffic in my district were entered upon have been issued by the authority of the Road Board, and I feel sure that if these forms were used generally throughout the country they would give a fair criterion of what the traffic is. The forms are published by Messrs. Waterlow & Sons, and if road authorities would adopt these we should further uniformity in the taking of road traffic records.

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MR. STUBBS: Where the subsoil is clay I think it is a mistake to use pitching on it. I should advise filling in the interstices with broken millstone grit, roll it in, and water it after putting on four and a half inches of limestone as suggested. There is no difficulty in rolling limestone, it is as good to roll as any granite. I do not, however, use limestone on main roads, or for any roads carrying very heavy traffic. We have very large boiler works in the town, and from these works they send away boilers of forty tons weight. We have come to an arrangement with the proprietors of these works under which they have their wheels wooden shod. Since that has been done we have had no complaints of setts being broken. Previous to the adoption of that system we had sent in a claim to these makers for 2000*l.* for two journeys, a big boiler having made a groove the whole way. The makers asked what I would suggest, and I said, "Shoe the wheels with smooth wooden tyres." I do not think there has been a broken sett since. With regard to material, I use granite on a main road, I have had to tar paint every two years, and it keeps in good condition, but I use limestone for private roads where traffic is light. It keeps a better surface than granite.

MR. G. W. LACEY: I think that this matter requires a great deal of discussion before a proper standard can be arrived at. I should like to ask Mr. Brodie if he can give us some means whereby, with reasonable accuracy, the character of traffic along a road can be estimated. It is a comparatively easy matter to obtain the number of vehicles, and the various kinds of vehicles, but to ascertain the weights of rapidly moving loads, consisting of altogether different kinds of goods is almost an impossibility, and I cannot see how you can reduce traffic to terms of tons per hour with any reasonable degree of accuracy. The sheets of the Road Board are very useful for traffic estimation. I have had reason to use them myself, as we have been making an application to the board for a grant. There is also the question of broad-wheeled and narrow-wheeled traffic; the effect of each on the road is quite different. Again, the traffic in one district is not comparable in the slightest degree with what takes place in another. Coming to the specification, there are some points in it with which I agree, and others with which I cannot. With regard to limestone, there is no question that for taking the tar well, and making a close and compact road, no stone is equal to

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limestone; but, as you are aware, it cannot compare with granite in other important respects. We have a few sections of granite tar-macadam laid down in Shropshire, some of which are very good, and some very bad. There are instances of granite macadam there showing most excellent results, but it must be remembered that the traffic conditions are quite different from those which prevail at Sidcup, where the trials are being made. What might last twelve months at Sidcup, we should expect to last four or five or more years in Shropshire. With regard to tarring and gritting, I think a lot depends on the class of material used. If you are using a fine-grade material it gives a smooth surface which need not, I think, be tarred and gritted; if a coarser-grade material be used for the top coating it may be necessary to do it. If it is found, after the macadam has been down some time, that there are crevices in the surface material, it should be tarred and gritted to maintain the water-tightness of the road. I had an instance of that where the material used was of rather coarse gauge, and the crevices between the stones were quite obvious. I quite agree that it is better not to put stone down of different gauges, but that it should be graded and mixed together, as with a proper amount of small stone you get lesser interstices and more homogeneity in the surface crust. It will then carry the traffic better than if there were large interstices, in which case you have got to make a surface skin to prevent water penetrating.

Sir George Gibb: This is a technical subject, and, as you are all aware, I have no technical experience, but I will just say a word about statistics, on which I do know something. I am glad the Road Board form has been referred to with approval. A great deal of trouble has been taken in preparing it, and we did the best we could to provide a form which would suit a variety of conditions. Of course, in classification you cannot reproduce all details, you must classify on some group and some average. Although it is quite impossible to reproduce in the tonnage figures the exact tonnage that passes over a road, still it is wonderful how true the averages are, and how near to what the actual working would give. Therefore I think it is quite useful to employ the figures of tonnage on a computed basis, and I would suggest the basis of computation used by the Road Board be generally adopted. They were prepared by a number of very skilled gentlemen, all of whom had experience of different kinds

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of traffic. I am not sure that I like the idea of dividing the figures into very small units. Of course, what we have to aim at in classification is to get an accuracy, as near as we can, and then something that can be easily memorised for purposes of comparison. On the question of accuracy, is it really a fact that the difference between a six-yards road, and a seven-yards road is substantial? Supposing you have a certain quantity of traffic, composed of different classes of vehicles, on a road six yards wide, and then you have the same quantity of traffic on a road seven yards wide, is the wearing effect on the road in the one one-sixth more than it is in the other? I have no right to suggest an opinion on that; I put it to you as a query, still I confess I am sceptical, and I rather think that if you get the traffic in tons per day, without dividing it by the width of the road in yards, you get a figure that is accurate in itself, that is easily memorised, and a figure which is true for a certain variation of width. Probably if you reduce all figures to tons per yard of width you get a statistical figure which is almost too minute for the rough-and-tumble of ordinary use. Then, again, if you reduce it to per hour or per annum, in the one case you get a figure that is too small, and in the other case you get a figure that is too large. My inclination is always towards a simple figure; the number of vehicles per day—you may prefer a day of sixteen hours, or a day of twelve hours. So you get at the number of tons per day, and then you have figures which I think will be found adequate.

The President: I should just like to refer to one factor which has been omitted in considering the volume of traffic, and that is that the less the volume on a given road the greater is the proportion of that traffic using the centre of the road. You cannot compare the traffic of a heavy street with the traffic on an ordinary eighteen-feet country road. What we country surveyors have to face is the universal user of the centre of the road. Some years ago I made careful tests on a country main road leading out of Aylesbury, and I found that on the central seven feet of that twenty-one feet road there was three times the amount of traffic that there was on the haunches. If that was so ten years ago, how much more would it be the case now. I suggest that it is of the utmost importance in discussing the factor of traffic to bear in mind the class of traffic, and the extent to which it is able to keep to the centre of the road.

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Mr. Brodie, acknowledging the vote of thanks, said: The main points of the discussion appear to have taken the direction of traffic enumeration, which I dismissed somewhat briefly. I have no doubt that we might well have a paper devoted entirely to that part of the subject, so great is its interest and importance. I have myself taken some trouble during the past two years to obtain reliable information with regard to the traffic on some of the roads in my district, and I have taken the traffic on the first working day of every month for two years. Now, in a place like Blackpool, the traffic at this time of the year is more than one hundred times what it is in January or February; therefore figures taken now or in the depth of winter would give no idea of the volume of traffic using the roads. Some of you may think this is over-elaborating the subject, but it is most desirable to obtain accurate data as to traffic, so that we may be successful in laying down roads to accommodate the traffic in each district. With regard to other points Mr. Price referred to the specification, and suggested it was not quite in accordance with my own practice. I can assure Mr. Price that the Marine Drive road, which is nearly level from end to end, and is forty feet in width, has been constructed practically on the lines laid down in the paper. Singularly enough, no one put the question to me what the cost of a road made to this specification would be. All the work was done under contract, and the cost was at the rate of 1*s*. 9*d*. for the rubble foundation, and of about 2*s*. 6*d*. for five inches of asphalte on the top. You thus get a total cost of about 4*s*. 3*d*. per square yard. As to the question of rolling with a 10-ton roller, it is true that part of the road was finished with a smaller roller—a four and a half ton. That was left to the judgment of the contractor. The whole work was done in a way which was very creditable to the contractor, so much so that very little has been spent on it during the seven or eight years it has been laid down. Referring to the question of statistics, in the specification, I think that if we are to give a contractor a fair chance of making roads successfully we must give him the most reliable statistics possible to work upon. I am interested in what Mr. Willis said about vitrified material, but I should not expect to get good results from a vitrified upper crust. I quite agree with what Mr. Winter said about the loose way in which the word "bitumen" is used, and I should be obliged to the Road Board if they would simplify the nomenclature of road materials. What I meant was tar-bound or pitch-bound roads.

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SOME NOTES ON ROAD MAINTENANCE IN COUNTY ARMAGH.

By R. H. DORMAN, M.Inst.C.E., County Surveyor, Armagh Co.

In this paper the Author desires to give some account of the rate of progress in respect to road maintenance, and to describe briefly some of the methods adopted for the improvement of the roads in recent years in County Armagh. Previous to the passing of the Local Government Act (Ireland), 1899, the road authority for each county in Ireland was the Grand Jury, which body was empanelled twice a year for the consideration of criminal and fiscal business, but after transacting the business laid before them they were discharged and had no further jurisdiction until called together again at the next assizes; the sole authority in charge of the roads in the interval being the county surveyor. The Grand Juries, not being corporate bodies, had no power to purchase road machinery or plant of any sort; as a consequence, until the duties of the Grand Juries in respect to road maintenance were taken over by the county councils under the Local Government Act, little progress could be made in matters of road maintenance, and it is not, therefore, surprising that the roads in Ireland were generally in a very indifferent state previous to the passing of the Act. In a few important counties a little steam rolling had been done by hired rollers, and in a few counties in which the traffic was light, and suitable material was available, it was possible to make fairly good roads, but as a rule the roads were bad, and amongst the worst were those in County Armagh. In this county, as in every other county in Ireland, the roads were farmed out to contractors, who took over the whole responsibility for their maintenance, but who, being for the most part quite ignorant of the best methods of maintenance, and having no rollers or other appliances, naturally failed to make any improvement in their condition, and in many cases, instead of improving them, let them go from bad to worse.

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Unfortunately, the Local Government Act did not provide for any system of road maintenance except by contract, but in a year or two after the Act came into force, a provisional order was passed authorising the adoption of direct labour. From the year in which this order became law dates the first signs of rapid improvement in the condition of the roads in Ireland. Not that everything then was plain sailing, because the strongest opposition was offered to any change by the road contractors, who up to this period had a monopoly of the roads, and by many of the rural district councils in the country, which bodies are for the most part extremely conservative in matters of road maintenance, and view with suspicion any change from existing methods. A number of county councils, however, taking a broader and more comprehensive view of the subject than the rural district councils, succeeded in overcoming their opposition, and in introducing direct labour on the roads; other county councils, while not abolishing the contract system, modified the old system in many respects and introduced steam rolling and other modern methods; the remaining county councils, while still following the old lines, cannot fail to see the better condition of the roads effected by improved methods, and it is therefore only a matter of a little time before every county will have adopted better and more up-to-date methods of maintenance.

The County Council of Armagh was one of the first bodies to recognise the advantages of direct labour, and in 1907 they adopted the system for all the first-class roads in the county, and since then there has been a rapid and continuous improvement in their condition, with practically no increase in expenditure. The results have, indeed, been so satisfactory that some of the rural district councils are now eager to adopt methods of maintenance more in accordance with modern principles for their second and third-class roads, and the county council has just purchased light rollers at the request of two of these councils, for use on the bye-roads in their districts. As soon as the first rollers and scarifiers were purchased in County Armagh, the Author proceeded to scarify and reform the roads so as to bring them into shape, to a proper camber, and to a suitable width in each case. In some places the roads were hog-backed, in others they were concave; in some places too wide, in others too narrow. The hog-backed parts were scarified, sometimes 12 inches to 18 inches deep, and the road widened out and rolled; if there was

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any surplus material it was screened and utilised for filling up concave parts of the same road or an adjoining road.

Where the roads were too narrow, they were cut back, a little hard material put in along the sides and rolled, while where too wide, a sod curb was laid along the existing surface to define the proper width, and some soil packed behind to form a margin. This work could only be accomplished by degrees as funds became available and as the Author succeeded in collecting and training a sufficient staff of foremen, surfacemen, and labourers. At the end of five years, however, most of the first-class roads, embracing about four hundred and fifty miles, had been more or less reformed. During this period no great effort was made to obtain material of the best wearing properties, the chief object being to get the roads into shape, and to roll in any fairly hard material, so as to form a subcrust for a surface coat of harder material. Over a large portion of the county, the only local stone available is a very soft limestone, but this, when broken to a 2½-inch to 3-inch ring and rolled in a thick coat from 4 inches to 5 inches, makes a very compact subcrust, and, for light traffic, it makes by no means a bad surface, if kept clean and not allowed to track. The roads having been got into some sort of shape, more attention had to be paid to the quality of the material provided and to the opening up of quarries containing suitable material. Not much difficulty was experienced in this matter; although in parts of the county it is impossible to obtain good stone of any sort locally, still in other parts there is an ample supply of whinstone, hard slatestone, etc., so that the difficulty resolves itself into a question of transport over distances seldom exceeding fifteen to twenty miles. In some cases also a large proportion of the stone can be conveyed to within carting distance of its destination by rail or barge, so that, for the most part, suitable stone can be laid down on the roads without the aid of a traction engine or motor. Whinstone usually costs from 2*s.* 6*d.* to 3*s.* 3*d.* in the quarries, and hard slatestone 2*s.* to 2*s.* 6*d.*, and, when laid down on the roads, from 3*s.* to 6*s.* a ton, so that the cost of material cannot be considered excessive. In one large quarry, owned by the county council, consisting of hard slatestone, the stone is raised for 10*d.* a ton, broken by hand to a 2¾-inch ring for 1*s.* 2*d.*, run down a short length of tram line and loaded into railway trucks for 2*d.* a ton, then railed to Armagh, a distance of ten miles, for

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1*s*. 3*d*. a ton, making a total sum of 3*s*. 3*d*. a ton for the stone at ten miles from the quarry.

In those parts of the district, in which only soft limestone is available locally, a proportion of the stone is now being treated with a preparation of tar, and so far with excellent results. Last year, a special plant was laid down for the treatment of the stone, and during the summer about six hundred and fifty tons of stone were dealt with. This plant consists of a crane for lifting the stone from the quarry floor to a platform, from whence it is tipped into an open inclined channel, the floor of which is formed of iron plates, beneath which is the flue, extending from the furnace built at the lower end of the incline for the purpose of heating the stone. From the channel, after being sufficiently heated and dried, the stone passes into the mixer. This mixer is cylindrical in shape, and has tee irons riveted on the inside at an angle, so that the stone, as it drops from the tail of the shoot into the mixer, is passed along the mixer, as it revolves, from the upper to the lower end, where it discharges into barrows, and is then conveyed to the stacking ground close at hand. As the stone passes through the mixer, the preparation of tar and pitch is added in the requisite proportion from a tap attached to a pipe leading from a tank in which the preparation is stored. The mixer is actuated by gearing after the manner of a threshing mill and driven by a pair of horses. This method of gearing and working the mixer is very simple and economical. A pair of light horses are quite able to drive the machine, and, when not working, they can be immediately detached and put to other work. The plant was designed by Messrs. Goodwin and Barsby of Leicester. No difficulty is experienced in working the plant, and it is, on the whole, very satisfactory. The total cost of the plant, including erection, amounted to 230*l*. From thirty-five to forty tons of stone can be treated per fine working day of ten hours at an average cost of treating the stone of 3*s*. 2·4*d*. a ton, made up as follows:—

	£	s.	d.
Labour, 16 men at 2*s*. 2*d*. a day	1	14	8
1 Foreman at 4*s*. a day		4	0
Horsework, 2 horses at 4*s*. 6*d*.		9	0
Oil			8
Coal, 5 cwt. of Scotch coal		5	0
Tar, 266 gallons of gas tar at 2*d*. per gallon	2	4	4
Pitch, 6½ cwt. pitch at 2*l*. 10*s*. a ton		16	8
Cartage of tar and pitch to quarry		5	0
Total cost of treating 37 tons stone	£5	18	6

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Material.—The Author is a little sceptical about any great advantage to be derived from specifying that the material for the surface crust shall consist of stone of varying sizes, such as sixty per cent. of 2½-inch gauge, thirty per cent. of 2½-inch gauge to 1¼-inch gauge, etc. He considers it of much more importance that the stone should be broken cubical, and instead of having a large proportion of fine stone, he would like all the stone spread off for the roller to lie between 1¾ inch and 2¾ inch. Stone of this size, of average hardness, spread off in a 4-inch coat, on a lightly scarified surface, rolls in very tight, and no apparent voids will be found in the coat.

Quality of Materials.—The principal varieties of stone available for road metal in County Armagh are whinstone, slatestone, and limestone, of varying degrees of hardness and toughness; but coarse-grained granite, elvanite, and felstone, etc., are also to be found in places. In the southern portion of the county stone is to be found, probably of Silurian origin, but which has apparently been subject to metamorphic action, so hard and tough that it is only raised with extreme difficulty, and cannot be broken by hand except in small quantities. This stone, if broken to a small gauge, would doubtless make a very perfect and durable road, but when broken to a 2½-inch to 2¾-inch gauge, and rolled in, it wears into a very rough surface, very unpleasant to travel over: the same remark applies to coarse-grained granite when broken to a large size; but this material when broken fine, although it makes a smooth even surface for very light traffic, is quite unable to carry heavy traffic, and wears very quickly. For ordinary purposes of comparison, the relative values of Armagh limestone, slatestone, and whinstone may be taken as one, two, and three; that is to say, average samples of these several varieties may be selected, and it will be found that they will, when used as road metal, approximately wear in the proportion of one, two, three. Of course, it will be found that a hard slatestone will wear better than a soft whinstone, and a good limestone better than a soft flaky slatestone; but the figures given above are fair average values. It does not follow, however, that in all cases a stone should be chosen for road metal because it seems to be the most economical when considered on the basis set out above: for instance, the price of whinstone on a particular road may be 9*s.* a ton, and limestone 4*s.*, or it may be only 2*s.* 6*d.* a ton; but it should not therefore be assumed that whinstone should be

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selected in the first case and limestone in the second; there are many other factors to be considered in each case besides wearing properties: for example, in strengthening and making up a bad road in the first instance, it will generally be an economy to use a large quantity of a cheap and poor kind of material to put body into the road, rather than a small quantity of material of better quality: on the other hand, no practical man would think of coating or repairing a whinstone road with soft limestone, no matter what the relative prices. Other factors to be considered in the selection of a stone are the traffic over the road on which it is to be used, the amount of mud and dust created, the road foundation, the subsoil, the drainage, the situation, and the gradients. A few examples will suffice to show why these items should be taken into account. On a heavily trafficked road, a hard wear-resisting material is, of course, required even if the cost is out of proportion to inferior material. In populous districts and roads carrying motor traffic, the creation of mud and dust has to be carefully avoided. In the case of a bad foundation or a weak subsoil, cross breaking and shearing of the weak surface crust is liable to occur, so that a material which will roll down into a close compact mass, and will resist cross breaking better than a substance like hard slatestone, which has little binding properties in itself, should be used. On the other hand, on a badly drained road, soft limestone would wear out very rapidly, while the increased wear of slatestone in such a position might be hardly noticeable. Again, considering the situation and gradients of a road. On a high, wind-swept road, or a hard steep gradient, a road coated with a stone possessing little binding properties would rapidly break up and go to pieces in dry weather, while a limestone, if used, would probably be hardly affected by these circumstances. The matter of foothold is another item which has to be taken into consideration in selecting material, and one on which a whole paper might be written.

Steam Rolling.—The Armagh County Council now own eight rollers and a ninth has been ordered. Five of these rollers weigh 10 tons each, one weighs 12 tons, and two 7 tons each, these latter being for use chiefly on bog roads and on second- and third-class roads. The 10-ton rollers have been found heavy enough for the work required from them up to the present, but as the roads are becoming stronger and a better class of material is being provided, it is found that better and tighter

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roads can be made with heavier rollers, and therefore when the present 10-ton rollers are worn out, the Author hopes to see them replaced by 12½-ton rollers on the leading roads, except, of course, when a special binder is used, which can be better treated with a light roller.

In Ireland the use of special binders is only in the experimental stage, and it seems probable that for some years to come, in order to save initial expenditure, the majority of the roads will continue to be water-bound except in or adjacent to the larger towns or on some of those roads towards which a grant in aid is made for improvement, by the Road Board. The Author will, therefore, direct his remarks chiefly to the steam-rolling of water-bound roads, referring only incidentally to such roads under his control as have been treated with special binders. There is a vast difference between a rolled road which has been reformed, coated with hard metal of uniform quality, well dry-rolled, bound with a small proportion of clean road scrapings, and finished off with screened chippings, and an ill-formed road on which a coat of indifferent metal is thrown, smothered with mud and finished off any way; but it is remarkable how much of this bad work is carried out in many places. This sort of work is frequently to be found in Ireland on roads in the hands of contractors, who are insufficiently supervised, the chief object of a road contractor being, of course, to save expense by getting the roller which he has hired from the County Council off a road as soon as possible, and so he lumps down the stone in a heavy coat, half dry-rolls it, flings a quantity of mud over it, and washes it in, no attempt having been made to reform and bring the existing surface to a proper camber in the first instance. Another cause of bad rolling is the incapacity of those in charge of the rolling operations. A capable assistant or foreman who knows his work will insist on a road being properly finished off, but too often, the man in charge, while he thinks he knows all there is to be learnt about steam-rolling, really knows very little about it; he has not mastered the little details which are the essentials of good rolling. To ensure good rolling, it is generally necessary to more or less reform the existing surface of a road before spreading off any stone. Sometimes the necessary work will entail heavy scarifying, reforming, screening, and partial removal of the old material; sometimes only a little light scarifying and reforming is necessary, occasionally only a little

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picking here and there. As a rule, it is advisable to reform the old surface, to bring it to the same camber as the finished surface, the sides to the same level, and to lightly dry-roll before spreading off the new coat.

The thickness of a new coat of unrolled stone should not exceed 4½ inches or 5 inches at the outside; such a coat when rolled in will be from 3½ inches to 4 inches thick. When the new coat has been spread off it should be thoroughly dry-rolled, and as any slacks or depressions show, they should be made up and the whole surface brought to a uniform camber of 1 in 30. This cross fall should not be judged entirely by the eye, but should be checked by means of a template and spirit level. After the stone has been thoroughly dry-rolled, a very small quantity of clean road-scrapings should be spread off, watered and swept in, a quantity of chippings (about 1 ton to every 12 tons of stone), when available, should then be applied, and the rolling continued until a firm, hard, and tight surface has been obtained. After the operation of rolling has been completed, the Author has been in the habit in many cases of spreading off a quantity of screened chippings on the finished surface; these chippings prevent the surface breaking up after being rolled should very dry weather occur, but as they are quickly swept away by rapid motor traffic, and are also injurious to rubber tyres, he is discontinuing the practice.

Some short lengths of roads have been laid down with tar-macadam in County Armagh, and some experiments have also been made of grouting surfaces of newly-laid stone, which have been dry-rolled, with tarvia, and from the experience so far gained, the Author is entirely in favour of tar-macadam over grouting with tar; he is, however, decidedly opposed to the finishing off the surface with a veneer of tar; undoubtedly, this practice may result in roads of greater wearing properties, and which are practically dustless, as compared with roads without this veneer, but it can never give a satisfactory foothold in all conditions of weather.

No preparation has yet been introduced which makes an ideal binder for roads, and it is questionable if a perfect binder will ever be produced. A road possessing the rigidity of cast iron is not a perfect road for traffic, while there must be set up in any road crust of broken stone, bound with a substance possessing a certain amount of resilience or elasticity more or less internal stresses

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and friction under the jar of traffic, which will result in ultimate disintegration. The Author, however, looks on a road crust composed of broken stone set in a firm but slightly elastic binder, and with the stones showing on top, as the nearest approach that can be obtained to a perfect surface, and which most nearly meets the requirements of traffic on ordinary county roads.

Road Board Work.—Before concluding, the Author would like to give a brief description of the work carried out in County Armagh with the assistance of grants in aid from the Road Board and his appreciation of the very great benefits to be derived from these grants. His only regret is that the total annual grant to Ireland, which contains a mileage of roads far out of proportion to other portions of the United Kingdom, and where the roads are the chief, and in many places the only, means of communication, should be so small. Last year the amount allotted to County Armagh was 2700*l.*, and the county council, after setting aside 200*l.* for work in the urban districts, applied the balance to the following works of improvement.

No. 1: To reconstruct, widen, and steam-roll 666 perches of the road from Dublin to Derry between Armagh and Moy, 2533*l.* 5*s.* 3*d.*

No. 2: To scarify, reform, and make up 400 perches of road from Dublin to Belfast between the County Louth and Newry, 529*l.* 2*s.* 3*d.*

No. 3: To render the drainage complete, scarify, reform, and roll 200 perches of the road from Belfast to Armagh, between Portadown and Armagh, 533*l.* 6*s.* 8*d.*

These several works have been carried out by direct labour and completed in a satisfactory manner and are permanent works of improvement, which it is probable would never have been attempted by the county council and the district councils concerned without the assistance of the Road Board. The most important of these works, that is, the reconstruction of the Armagh to Moy road, involved the lowering and strengthening of a bog rampart, and was a difficult and troublesome piece of work. In order to test the relative values of tarred local limestone, whinstone, and slatestone, this length of road was divided into three sections, one section coated with tarred limestone, and the other two with whinstone and slatestone respectively, untreated. No appreciable difference is yet noticeable in the wearing properties of these several materials, but it will be interesting to note their ultimate values on this road.

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For the current year, the Road Board have allotted 1400*l.* towards works of improvement on the scheduled roads in County Armagh, and of this sum, the county council have approved of 1200*l.* being expended on the following works:—

No. 1: For draining, scarifying, reconstructing, strengthening, and coating with whinstone and slatestone, 300 perches of the road from Armagh to Belfast, at an estimated cost of 1172*l.*

No. 2: For widening the metalled portion of carriageway, strengthening and surfacing with whinstone, and draining 200 perches, also of the Armagh and Belfast Road. Estimate, 768*l.*

No. 3: For strengthening, surfacing with slatestone, improving gradients, draining, and reforming footpath on 88 perches of the road from Newry to Dublin. Estimate, 619*l.*

These several lengths of roads will be finished with water-bound macadam except in the case of No. 1, a portion of which will be treated with rocmac, and a smaller portion which it is proposed to try with another proprietary article as an experiment. It may be asked why the county council are not treating the whole of these lengths of roads with tar or some other special binder. The answer is that the Author has advised his Council to render the drainage of the roads complete, to strengthen the foundations, and to improve the gradients of the roads where necessary before going to great expense in putting on an improved surface coat; and also to experiment to some extent in the first instance, and ascertain definitely by trial what is the best and most economical material and system to adopt before launching out into any particular method of resurfacing on new lines, which might not eventually prove satisfactory.

DISCUSSION.

Mr. E. P. Hooley: I propose a vote of thanks to Mr. Dorman. I do not know whether you are aware of some of the difficulties they have in Ireland in connection with roads, but it may interest you to know that many things which are perfectly simple to us are sources of great difficulty there. I was surprised to find that a short time ago it was illegal to use a steam roller in Ireland. They have not had the steam traction engine there yet, however! If you saw Mr. Dorman's roads you would agree that they are roads to be proud of; they are indeed excellent.

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Mr. Dorman has faced the situation as no other man in Ireland has, and it is greatly to his credit that he has done so.

Mr. W. H. Leete: I will second the vote. I attended a conference in Ireland, and it was interesting to learn that the Irish surveyors had only just begun to use the steam roller.

The President: Before putting the vote of thanks, I should like to thank Mr. Dorman for his admirable paper, which he prepared at my earnest request. It is always interesting to know what other people are doing, and we have here an example of what can be done with very small funds. This is rendered possible to a very large extent, as it seems to me, by the lower prices of materials—prices that make our mouths water. We find in Ireland that material is delivered at 2*s.* 6*d.* and 3*s.* 6*d.* per ton, which in England costs 15*s.*, 20*s.*, and 22*s.* per ton. That is a great contrast, and I notice also that the price of labour is most extraordinary—2*s.* 2*d.* per day. The price for horse work, too—I presume a horse and man is meant,—is 4*s.* 6*d.* per day. It is fortunate for them in Armagh that they have these conditions, and are thus able, with comparatively small funds, to effect the improvements we have had described to us. Some of the roads in Armagh are excellent, but the roads in Ireland generally are behind the times, and one cannot be suprised at it, in view of the old, inefficent system of administration which prevailed until recently. Nobody, however, could visit the roads in County Dublin, for instance, without seeing what an enormous amount of energy is being put into the work. It is a pleasurable duty to congratulate them, and to do anything we can to help them to make up for the defects of the old time.

Mr. Dorman, replying to the vote of thanks, said: I may say that my first knowledge of road making was acquired in Middlesex, where I served under the present surveyor of Manchester. In Ireland I had a very uphill battle. All of us have very uphill work there, but I find that if you persevere with your work, and peg away, in the end the District Councils and County Councils will give you their confidence, and instead of opposing everything will commence to support you and back you up.

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SCOTTISH ROADS.

By ALLAN STEVENSON (*Member*), County Road Surveyor, Ayr.

This subject is a wide one, and the Author must deal with it in very general terms. The variety of the physical features of Scotland demand provision of roads suitable for the traffic of each district—on the one hand numerous manufacturing industries and large centres of population, and on the other hand large areas sparsely populated with no industry except agriculture. Notwithstanding the extensive system of roads which the country possesses, due in a great measure to its mineral resources, the roads would be altogether inadequate now to meet the requirements had not the railway system come into existence in the first half of last century.

Prior to 1878 the main roads were nearly all turnpikes, one or two counties excepted. These turnpike roads were maintained from the revenues of the turnpikes or toll bars, but as soon as the railway system extended, the traffic on the roads, except for short distances, decreased, and the revenue for their maintenance diminished. In the Author's experience of turnpike roads the varying quantities of traffic and revenue produced an irregular and inefficient system of maintenance, there being sufficient revenue from some tolls to maintain the roads from which it was raised, but more than frequently their revenue was altogether inadequate to maintain them. A system such as this could not make for uniformity in upkeep; hence a few roads were in a good, and the remainder in a poor, condition.

In every county there were also a large number of roads of secondary importance, maintained by what was termed "Statute Labour," but these roads were only kept in such repair as to be passable, and so as not to draw away the traffic from the toll bar. About the middle of last century "Statute Labour" was abolished, and an assessment levied in each parish instead. These times are now passed, and the abolition of Turnpike and "Statute

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Labour" took place on the passing of the Roads and Bridges (Scotland) Act, 1878. The revenue for the maintenance of all the highways throughout Scotland is raised by assessment, one half payable by the owner and the other half by the occupier. For the management of the highways, Councils are elected in each county, and these Councils are again subdivided into district committees where the counties are large. The rates of assessment vary in each county and district according to its requirements and the importance of the highways. As surveyors, we have no concern regarding the finance but only in the expenditure, and our aim should be to do the best we can with the revenues at our disposal and to meet the requirements and demands of the times in which we live.

The first means of locomotion to cause more attention being given to road surfaces, were the bicycle and road locomotive—the one light and easy, the other the reverse. In nearly all counties in Scotland at this period the metal was spread upon the roads in beds in a loose manner in the autumn season, and the traffic during winter consolidated it into the road surface, so that in spring it was fairly smooth if it had been properly attended to. This system practically prohibited bicycle traffic during the autumn and winter, and counties, through the voice of public opinion, had to find other methods for consolidating the new-laid road metal. The introduction of the steam road roller brought a great and beneficial change in road maintenance, giving at once a smooth and finished surface and an improved and comfortable road for the traffic. In many districts the steam roller was strenuously opposed for a time as being a waste of material by crushing it in the process of rolling, etc., but all have fallen into line even in the remote Highland districts. From the introduction of road rollers onwards immense improvement had been made in the general condition of highways. The recent introduction of the motor car has, however, completely altered the whole of the system of road maintenance, and counties have now, in order to meet this traffic, to face the question of bringing up the standard of all the roads, more particularly through main trunk roads, to carry traction engine and motor traffic of various kinds by widening, draining, strengthening, selection of better material for maintenance, consolidation of the new surfaces, binding material, and last, but not the least difficult, the laying of the dust.

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While it is undoubted all these works, properly carried out, will lengthen the life of and bring the highways into a much better condition for all traffic—particularly motor car traffic—there is a very restraining element to contend with, namely, the cost of attaining this ideal, as the average ratepayer has a strongly rooted objection to contributing to any increased cost for a traffic with which he has no sympathy.

So long as counties are responsible for the maintenance of the roads, and one county has a high assessable value, and another a low assessable value, the improvement of the roads will not proceed in a uniform manner. So far, however, as circumstances permit, the desire for improvement of the highways is, the Author thinks, general all over Scotland. Ever since the Road and Bridges Act, 1878, came into operation in this county, numerous improvements have been made in cutting hills and levelling up hollows to improve gradients, widening portions of highways, opening out curves, widening and rebuilding bridges, etc. This work all tends to the comfort of the users of the road, but a great improvement still remains to be carried out. This applies to all counties.

The largely increased cost necessary to maintain the main trunk roads in a state to suit the motor traffic of different kinds must, at no distant date, become acute, and the necessity of considering some means whereby a contribution for direct maintenance be made from those creating the increased cost appears only fair and reasonable. From what source this is to be obtained the Author does not stop to inquire.

Every district in Scotland for the past few years has been experimenting with materials for laying the dust and increasing the life of the road treated, but in only a few counties has a bituminous binder been applied on an extensive scale, the cost in most other instances being the deterrent.

Although all this work is in an experimental stage at present, there is no doubt statistics will shortly be available to show that by the adoption of certain methods certain results will follow. Everything is being carried out to the advantage of the user of the road by self-propelled traffic; some provision is also being made for the humble individuals who have been compelled in a measure to forsake the highway, by the provision of footpaths for their use. Many new and improved footpaths are being laid in populous places, and these add to the comfort of the inhabitants.

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Since the Imperial Road Board was created and grants given towards various works for the improvement of main trunk roads, such as draining, widening, strengthening of the crust, improving of the corners, etc., a good deal has been done in many counties. It was thought by many in Scotland these grants should be made by the Road Board to cover the entire cost of any of the above or other approved improvements, but the Board have decided that the counties must contribute a proportion of the cost. Much can be said in favour of this method as stimulating a more active interest by counties in seeing the grants are judiciously employed in making real improvements; but, on the other hand, it forms a seriously increased expenditure if the improvements are extensive.

Around large cities and burghs with large populations the counties are strengthening and improving the surface of the road by the use of tar macadam, tar grouting, tar spraying, and in various other ways. In villages and on other main roads in the country districts similar improvements are being carried out, all for the purpose of extending the life of the roads and the laying of the dust.

On account of the climatic conditions in Scotland, there should be experiments made all over the country and careful statistics prepared with the view of obtaining a better knowledge of the best materials to use under given conditions. These experiments, if carried out by the Road Board, would educate and encourage counties in dealing with the question of maintenance in an economical manner and bringing the road surfaces into good condition.

While giving all attention to the improvement of road surfaces another form of traffic arises to destroy them, viz. motor charabanc and commercial motor traffic. These means of locomotion will, with the improved roads, increase in number and the life of the maintenance of the highways be correspondingly shortened. Since the introduction of motor-car traffic the life of the ordinary maintenance without special treatment of trunk roads has been reduced from a life of eight to ten years to a life of four to five years, and in some cases less. The rate of expenditure has increased in this county during the last ten years by fully thirty per cent., and the experience of other counties in Scotland is similar. If this special traffic increases in the same ratio as it has done in the past, county rates cannot maintain

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the roads in good condition without obtaining some relief from the burden thrown upon them of providing for a traffic they do not create. The traffic was, until recent times, comparatively local and circumscribed, but in these times it may be in the south of Scotland to-day and in the north of Scotland to-morrow. Formerly the traffic was slowly driven, now it is driven at a legalised speed of twenty miles an hour, and, be it observed, the speed is frequently very much greater. The same remarks apply to motor traction with the legalised speed of five miles per hour.

In one district in Ayrshire motor waggons with a load of six to eight tons are a regular traffic. In damp or wet weather or after frost this traffic in a few days destroys the surface of the road, upon which a very heavy expenditure is annually made. This traffic is carried on in competition with railways. The latter have to purchase land and equip their own road under Acts of Parliament, whereas the traffic by motor waggons, although legalised on the highways, does not contribute to their maintenance, and the county is therefore contributing to the profits of the owners and bearing the cost of the highway maintenance. Contributions should come from this traffic towards the additional cost incurred by the use of the highway, and the same remark applies to all heavy self-propelled traffic.

Traction engines are not licensed in Scotland, and can move to any part in one county, and from one county to another without a permit, and also on any highway, however unsuited to carry that traffic.

The Author trusts some points may arise from these notes, which may be the means of a little profitable discussion.

DISCUSSION.

MR. BLAIR: I beg to move a vote of thanks to Mr. Stevenson for his paper. There are many points in it which command our sympathy, such as the influence of motor traffic and the cost of attaining the ideal road to accommodate it. The paper pointed to the fact that the increased cost of upkeep is due to motor traffic, which, though something is now paid through the petrol tax, some of us get nothing out of; London, for instance, has not received a cent. However, we are told that something may be put aside to go towards the cost of the enormous new

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highways to run east and west, north and south, which are to cost so many millions each. Gentlemen in the provinces do get some share of the petrol tax, though they have to charge their roads with more than would be the case if they did not receive it. Some argue that this is an unfair condition; on the other hand, some say it is a wise provision, as it shows that the authorities are spending that money on really necessary work, and on the whole it is perhaps not unreasonable.

Mr. Harpur: I second the proposition. I also sympathise with the Author in respect to the objection of the ratepayers to paying for the increased cost of road maintenance due to the new methods of traffic. No doubt there is a great aversion on the part of the local authorities to provide the money necessary to keep the roads in right condition for modern traffic. A great many people do not appreciate the difference in the cost of maintaining roads now and in former times. At the same time there can be no question that motor traffic of one kind or another has come and is going to stay. We have now to provide roads, to keep them in proper condition for that traffic, and it is a pity that the local authorities are slow to see the necessities that have to be met at the present time.

Mr. A. H. Campbell: In Scotland we regard Mr. Stevenson as probably our leading exponent of county highway construction and maintenance. Some commiseration has been expressed in regard to Ireland, but I have not yet heard the voice of sympathy for our position in Scotland. Those who shout the loudest generally get the most, and if we had in Parliament as much patriotism as regards Scotland as they have for Ireland, I think Scotland would get more than she does. The problem is as acute in Scotland as it is in Ireland, and probably more so, for this reason, Ireland is divided by the sea from the rest of the British Isles, and that keeps motors from going there, for they have not got water motors yet. In Scotland there is only a bridge to cross, and so motor traffic can get freely over. What is the condition of things in that connection? We have the Highland glens, sparsely populated, and the Lowland valleys, where nothing but sheep can find a living; yet through these run the great highways of communication between north and south. There are many miles without a house, and so what rateable value have we for the support of main roads in such places? And what have the roads to carry? What local traffic is there? Practically nothing at all in proportion

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to the traffic of a through kind. Yet these are the very conditions, as Mr. Stevenson knows, which constitute a handicap on the efficiency of the maintenance of our arterial highways. Indeed, no subject is of such essential importance to Scotland as that of the recognition of the national character of our great trunk highways. It is a pity that Sir George Gibb has gone, we were wishful this morning to give him an opportunity of hearing some faint echo of the complaints from Scotland, and we had hoped to draw from him not only a word of sympathy, but promises of cash in advance in aid of Scotland's highways.

Mr. Elford: One must have a heart of stone to withstand Mr. Campbell's request for sympathy, and I can assure him on behalf of all here, that Scotland has our heartfelt sympathy. Mr. Campbell seems to complain of the Imperial Parliament's neglect of Scotland; surely that must be the fault of Scotland, for on this side of the Border we sometimes think that we are ruled entirely by Scotchmen. Even Sir George Gibb is a Scotchman. I would suggest, therefore, that Scotchmen should appeal to the patriotism of their own countrymen who are at the helm. Seriously, I sincerely sympathise with the Scotch surveyors in regard to the unrestricted use of traction engines. In this country we have little control over them, and in Scotland they seem to have less. Motor traffic does contribute a substantial sum to the roads of the country through the petrol tax, and for the life of me I cannot understand why petrol driven vehicles should contribute, and steam vehicles should get off scot-free; for the latter are as great a source of expense as the former, especially in the rural districts.

Mr. J. S. Brodie: As one who spends his annual holiday in the Highlands, I can bear testimony to the excellent state of the roads, considering the slender resources with which the surveyors have to deal. I have frequently inspected the roads supervised by my friend Mr. Mackintosh, county surveyor in that enormous district of Argyleshire and Inverness-shire, and I have always been struck with the extremely good maintenance of the roads. It is most creditable to Scottish surveyors that they do such excellent work on such slender resources.

The President: I cordially support the vote of thanks. It is an excellent paper, and we sympathise with the Scotch surveyors, all the more so because we have similar troubles in England. I have had the pleasure of making a tour of inspection

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of certain golf courses in Scotland, and in doing so traversed admirable roads. They were in good condition, and free from dust. With all deference, I do submit that Scotland depends very largely on the alien tourist, and when I went away after a few days' delightful stay, I left my contribution towards the upkeep of the Scottish roads. In this world it is always a case of give and take, and in this matter of motor traffic we must not forget that after all, in a tourist country, allowance should be made that in proportion as they have better roads and better accommodation, the tourist traffic must increase. I know the Scottish surveyors do their work thoroughly well, and with credit to themselves and the admiration of all other engineers.

The vote of thanks was passed unanimously.

MR. ALLAN STEVENSON, in reply to the vote of thanks, said: I am old enough to remember when the district roads were under the old turnpike system, and in those days the amount of money derived from the toll-bars was absolutely inadequate in many cases to keep the roads in repair. I must confess that the County Councils are very much more willing to give us the machinery and appliances we require for the proper administration and maintenance of the roads than their predecessors were, and they have also largely taken advantage of the Road Board's grant. The result has been a great improvement in the roads of the country. The President has remarked that when the motorist goes to Scotland he leaves a contribution behind him, but that is not rated, and in the sparsely populated districts, which are often those most favoured by the tourist, the ratepayer gets no advantage from the increased traffic. There are the shooting lodges, of course, but the revenue derived from them is not in proportion to the benefit which their owners get from the maintenance of the roads. I am very pleased to have the sympathy of the English surveyors in all we are doing.

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HOW THE NEW DISTRICT COMMITTEES MAY PROMOTE THE PROGRESS OF OUR INSTITUTION.

By A. HORSBURGH CAMPBELL, M.Inst.C.E. (*Member*),
City Engineer, Edinburgh.

This paper will of necessity be brief: not that the subject with which it deals is in any way to be considered a small one, but that with respect to the object of the paper, there can be but one opinion: and that is the desirability of the new district committees each becoming a source of strength, a centre of influence and a power for good amongst the members in particular, and indirectly, those serving in the "rank-and-file" of the profession within the respective districts and not yet connected with the Institution.

That there is a great field still to cultivate, that there are many eligible men who still hold aloof from our ranks, either from indifference, for lack of that *esprit-de-corps* that should unite us, or because of their attachment to other bodies, is an admitted fact, and it is to be hoped that the new Constitution and the introduction of new aggressive work, and of personal influence may tend to the gathering in of such as ought to be members of one flock and units of ONE Incorporation. It is only right in passing to give a meed of praise to our retiring President, who, during his year of office, has induced a greater number of meetings, obtained larger gatherings at those meetings, and generally quickened interest to a degree not attained by any of his distinguished predecessors, and in this way has caught the spirit of the times, and has given a send-off to the new life of the Institution; but the immediate purpose of the paper is to endeavour to carry on this revived interest, to excite action where not yet aroused, and to give opportunity to the members of the Institution by the submission of this paper, for free discussion and ventilation for the diversity of view and expression of the varied opinions which

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are entertained in regard to the methods and means to be applied in the progress of our Institution.

I do not mean by such progress merely increase of members, but primarily for increase of usefulness, of professional and scientific betterment, and for those things which weigh even more heavily and which bulk more prominently than that of mere numerical strength. That there is much scope for this, must be patent to all thinking ones, when we consider that as yet we are too much as separate units, where we might be a combined organisation, our efforts too much of an individual kind rather than those of an organised body, so that we find :—

(1) The multiplicity of Associations and Institutions with their manifold branches instead of one powerful whole ; we find division and disunion instead of that "unity which is strength." But how are those divisions to be healed, and this Institution to become a vehicle of power and influence professionally?

Chiefly I answer (1) by the agency of the district committees, and indirectly (2) by the co-relationship of districts with central headquarters; (3) by means of an official magazine; (4) by the establishment, in connection with our Institution, of an intelligence bureau; and (5) by the granting of a Royal Charter. The last named of these, and probably the most important, can only hope to be obtained when the other steps have been successfully scaled.

It is well here to refer to the new Articles of Association and by-laws constituting the district committees.

Article 35 says: "District Committees of the Institution may be formed, and District Secretaries appointed, in accordance with the By-laws for the time being of the Institution, and there shall be referred to such Committees all such local or other business and matters as the By-laws for the time being shall prescribe, or as may be specially referred to them or any of them by the Council; but the Acts and resolutions of the District Committees shall not be binding upon the Institution unless approved of by the Council;" and again, in By-law 11, it is provided "for the purpose of promoting the increase and extension of professional science, knowledge and practice, and the interchange of views thereon, for educational purposes, and for the promotion of the professional interests, rights, powers, and privileges of the members, and the improvement of their professional status, and for the election of District Representatives of the

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Council, the United Kingdom, and such parts of the British Empire as are hereinafter mentioned, shall be divided into the following districts . . . ," and so on, to the number of some fifteen districts in all.

Although occupying such little space in the printed matter, four great countries and continents comprising districts twelve to fifteen, are considered so unimportant as to be disposed of in one short line, viz. Scotland, Ireland, India, and Africa; and in the course of the same section it is provided "that each District Committee may arrange for such meetings in its District as it thinks fit, but the business at such meetings can only be for the purpose above-mentioned, and such business as is incidentally necessary thereto."

I proceed now to discuss how our progress may be promoted.

I. *By the Agency of District Committees.*—The formation and constitution of those district committees is set forth in the extracts above given; but it must not be supposed that those committees—if they are at all to realise their utility and to rise to their expected level—will be restricted in their meetings or their services to the mere letter of the constitution bringing them into being.

The printed constitution is but the skeleton of the body, but the dry bones to the living reality. This reality must consist of the putting on of flesh, and the stirring to the depths of that as yet untouched body of opinion and of skill that still holds aloof, and that must be brought into a living unity with us as an Institution.

I suggest for the consideration and discussion of the members the following methods, amongst others which it is hoped will be submitted by members at the meeting, and which is indeed one of the purposes of this paper.

(1) Each district committee, being representative of a group of counties, may within its own sphere subdivide into counties.

(2) Each district should have a strong executive committee for the management and administration of its own affairs.

(3) Each district should, within itself, be a self-governing part of the whole, and should be permitted to realise its own independence.

(4) To maintain the corporate unity of the Institution, the district committees should be united by the medium of the general council of the Institution and the permanent officers at headquarters.

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(5) An officially recognised magazine or *Surveyor's Chronicle* should be established, with the editor-in-chief responsible to the Institution as one of the headquarters staff.

(6) Such an organisation, actively maintained, must eventually lead—in combination with other municipal services—to one result, *i.e.* the granting of a Royal Charter providing for efficiency of qualification, standardisation of skill, protection in the zealous and capable performance of duty, and mutual support and defence of members.

The foregoing are only suggestive and not by any means exhaustive of the sphere of influence which our Institution may yet command. I observed at a recent meeting—our friend Mr. E. J. Elford of Southend, the secretary of the Eastern District, asked for suggestions as to those new district committees. It was a sign of the times; the darkness before the dawn of that new day of restored energy and activity of life at headquarters, as well as in the remoter part of our realm.

But to elaborate briefly the several suggestions above submitted:—

(1) *Districts and District Committees*—with subdivision into county areas.

It will be felt, I think, that the districts created by the new constitution are still too large in area and too widespread in membership for them to exert the influence they otherwise might. Districts which, for instance, comprise five or six administrative counties of England, and in another instance the whole of Scotland, and again the whole of Ireland, cannot be considered sufficiently identical in local experience, and must be still too large and scattered to permit that frequency of contact which is so needful if interest is to be maintained.

Periodically (such as once, or preferably twice, a year) it is well that members resident in the same district should come together; but this infrequency of meeting is not calculated to knit so closely together the members as, say, a monthly—informal—meeting can do. Of course it will be said, "Oh, what is the good of systematising down to the county unit?" I answer, "Because the county unit is a well-defined homogeneous area, possessing in its county council, and in its several urban and rural district councils as local governing bodies, certain close community of interests, kindred concerns, and facilities for frequent meetings of the officers to discuss, learn, and profit by,"

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(2) The county unit has already been tried and found not wanting in the Kent county surveyor, the Somerset county and the Thames Valley surveyors, although possibly the last-named is not strictly the county of survey. Sufficient experience has now been obtained of those and kindred county sub-divisions of our Institution, to be assured that those can only be *for good*, and that their multiplication through the length and the breadth of the land is to be desired. This increase can only be successfully accomplished through the agency and under the guide and direction of (1) the General Council, but more particularly and in detail by (2) the district committees.

The General Council, as the focus and centre of influence, unifying and assimilating the many distinctly local efforts, aiding by advice, guiding by experience, and *encouraging by cash aid where necessary*, those new forms of activity; and secondly the district committee—being more local—by lending the practical assistance of its officers in the setting up in each county within its own area of a County Association or other suitable sub-section, officered not necessarily by the district officers, but by its own local chairman, secretary and committee. The functions and duties of those last named would necessarily be small, but not by any means unimportant: they would be in their nature sub-divisional officers, responsible through the district committee, and thereby, to the Council of the Institution, for the growth, interest and life and weal of their county members. It is not from Westminster that the outposts will be moved, won, and saved, but by the persuasion of one's Own, in their immediate neighbourhood. The members serving in those outposts will then find that they need not feel themselves as isolated, defenceless units, but fellow-members of a great body corporate, ready at all times to aid by advice, to stand together in sympathy, and to defend (if need be by financial succour) honour and merit undeservedly impeached.

(2) *District Executive Committees and Officers.*—It is upon them more than aught else will depend the progress of the Institution under their respective areas. They are the Intelligence Department between the suggested outpost officers, and the headquarters' permanent staff. Upon them will depend whether their districts are to be active centres of influence for pushing along the work, and for reviving and maintaining interest, which can only be done by frequency of meeting, enabling the

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formation of professional and personal friendships, having in each district, say, two meetings annually, one a summer meeting for district business, and for visitation of works; and one a winter meeting for discussion of papers on some scientific or professional topic; to be followed or accompanied, say, by an annual district soirée, or other form of social gathering.

And here I would beg leave to utter a note of dissent from that phrase in the new by-laws which provides that "*All* members," etc., etc., that is of the Institution, "shall be invited to attend the various district meetings"; this is quite *superfluous*, a waste of stationery, stamps, time and money, which I trust the Council may speedily correct. As illustration, take the recent annual meeting of the Scottish district at Stirling. There we were honoured by three or four visitors only from England, none from Ireland, none from Wales. Yet according to By-law 11, "every member, associate member and student"—about 1400 in all—is individually invited by a postal communication for the sake of about *sixty* local members and *three* from across the border; or, again, take the recent East Ham meeting, with an attendance of about thirty-six to forty all told, no less than about fourteen to fifteen hundred invitations are sent out, and this *waste of everything* repeated on the occasion of each meeting!! that one is disposed to ask, "To what purpose is this waste?" when moreover the fact of the meeting can be read in the technical Press over and over again. I respectfully submit that if we notify personally the *district members* only and announce in the Press notice of the meeting, "Members from other districts are cordially welcome by due notification to the district secretary," that this wanton waste of paper, printing, stamps and time will be saved to the Institution, and the district secretary much relieved.

But the district committees can do more than arrange two meetings annually; they can come in to fill the void between the private members and the Council that sits only at distant intervals at Westminster; they can be the medium of intelligence, the centre of information, the seat of succour to the brother down on his luck through some mischance that may have lain in wait upon him. I would, however, throw out this hint to my colleagues upon the Council, and invite the consideration of the members to the proposal for the Council itself to be more migratory, and less fixedly Westminster in its place

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of meeting. There are about twelve districts, excluding India and Africa; why not change the *venue* of our Council meetings so that say *once* a year or thereabouts, the Council, by holding its business meeting in that district, will come into close touch with the particular affairs of each district without neglecting its duty to the whole Institution? The presence of the Council—once annually—in each district could only react with benefit upon both the Council and the officers and members of that district. But, further, the district committees can, by their diligence, call into being that merely strictly local county administration already referred to. If they fail in this needed growth of our Institution work, who shall succeed? And I would therefore commend this propaganda to their best consideration.

(3) and (4) *Each district to be self-governing, and through the Secretaries to be in constant touch with Headquarters.*—This is essential to success; each must work out its own salvation along lines suited to its own locality, subject always to the nominal oversight and veto of the Council—to be evoked only in case of crisis or of need—that is, not interference from headquarters. That is allowing latitude and freedom for the expansion and development of the Institution along the varied channels and by the many ways that lead out of individual effort and official freedom; and the district committees may therefore vie with one another in devising each for itself new forms and ways suited to its own locality. But although self-governing, it is to be desired that the Council should have the benefit of new ideas and fresh district developments, so that they, as the central governing body, may communicate such developments to other districts. Therefore, another reason for the Council to be migratory in its meetings, and for frequency of correspondence, constancy of communication between General Secretary at headquarters and the hon. secretary of each district is to be encouraged.

(5) *An Official Magazine to be published.*—It is said, "Of making many books, there is no end." This doubtless is so, but the initiation of a magazine—to be published quarterly to begin with—is an equipment much to be desired of the strictly official work of our Institution. Consider what it may not accomplish for us, as the intelligence domestic bureau for its nigh fifteen hundred members as the voice and vehicle of official information

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concerning the work, ways, and progress of the Institution in its various districts, as a medium of direct interchange of individual and official thought and opinion on matters professional, and it may be, officially personal; further, as the collector and distributor of information, as the statistical centre and publisher on matters of solely Institution interest; as the publisher of official minutes, notices, reports, etc., connected with the Institution.

I do not suggest that such a magazine or chronicle should reproduce *in extenso* those papers and reports, many of which (like the present) may be a weariness of the flesh, but that there is a need for some such magazine, and a sphere for some such chronicle, is patent when it is remembered that, if we are to keep ourselves individually abreast of current professional views and literature, we have weekly to go through the countless columns of almost countless publications, to extract therefrom those tit-bits of information which appeal to our peculiar and personal needs and tastes. What is wanted in our professional literature is such a time saver as a surveyor's review giving ready references to things that matter to us as municipal and county engineers; so that we might go for further information to any particular article in the particular paper containing the article.

Such a chronicle as I suggest, capably edited by one more or less in responsible touch with the Council, has possibilities we cannot forecast for the betterment of our Institution. It would be, as regards purely Institution business, the *full* record; and as regards *science* and art as applied to our work, the informer and reference to the articles in other press publications. It would not therefore be competitive in any way with the existing technical press, which is so full and informative on such matters; but supplemental to that press on the important inner affairs of our Institution, and that which really matters to us as a profession.

(6) *Royal Charter.*—This surely is an aim worthy of us all. It may be but as yet an idle dream, an airy phantasy; still, it is a consummation worthy of our best aim. If it inspire us to proper purpose, to sustained integrity, to continued good work in the straightening up of crooked ways, and making plainer and easier for the multitudes we serve, life's rough paths, we shall have at least merited that mark of Royal favour in the granting of a Charter that will enfranchise our profession in this League and Union of Honour, and give it that material strength

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that shall wield power to defend collectively as our duty a member and a brother unworthily aspersed, and to succour him and them who, through no fault of their own, are falling in the Race.

May I hope, in conclusion, that the submission of these suggestions will induce a host of others which can point the way of work to our Council and officers for the continued progress of our Institution, and the betterment of our work in our respective spheres of public service?

DISCUSSION.

Mr. J. L. Redfern: I propose a vote of thanks to Mr. Campbell for his suggestive paper, which I have read with great interest. I feel sure the district committees will find in it many suggestive subjects, and I do not think for a moment that they will lack subjects for discussion. The professional side of the life of members of the Institution is bound to be well looked after by the district committees. What I would like them to look after more is the material welfare of members of the rank and file. It is suggested here that the district committees should make a great effort to rope in all surveyors who are not now members. I think there is a great field of useful work there. In the south-eastern district there are many men who are not connected with the Institution, and whom I hope we shall be able to get in. The pressing questions of superannuation and security of tenure are both prominently before us at present. It is admitted on all hands that superannuation is gaining ground with the Councils, and indeed it now does not need arguing, but it is more difficult to make people believe that security of tenure will be to the advantage of the governing bodies as well as to our members. My idea is that it will also benefit all parties concerned. The district committees will have to keep pestering every authority, both government and local, to grant us what we want at as early a date as possible. We know to what an extent members of public bodies are harassed in the discharge of their duties, and personally I found it necessary to bring an action for libel last year because of some libellous statements made in a local paper. I was successful in securing a verdict for damages and costs, and was able to get the costs; I did not press for the damages, as I did not want to be vindictive. It is not every member that comes out so successfully; not

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every member has the courage to go to court in a matter of that kind. I think it is the duty of the district committees to investigate cases of this kind, and when members are subjected to pin pricks remonstrances should be lodged by the committees, or by the Council itself. Members who knew they had the support of the district committees behind them in carrying out their duties with integrity would feel in a stronger position than they do now. The Committees should be able to scrutinise advertisements, and draw the attention of local authorities to the miserably inadequate salaries offered to professional men as assistants. A great deal can be done by the Council in suggesting to the committees proper terms. One of my assistants applied for an increase a few weeks ago. The committee recommended 20*l.* in instalments. I made a strong protest, and the result was that they gave 20*l.* at once. Members of the Council, who have gone through a preliminary training as assistants, should do their best to make the stepping stones to the higher grades easier for the junior members.

Mr. F. R. Phipps seconded. He said: This paper is one of vital importance, and it is the duty of the Council, and the members generally, to consider earnestly what can be done to improve the status of the members of the Institution. Suggestions have been made as to the steps the Council and committees may take to improve inadequate salaries, but what status have the members of the Council? We have no charter, like the Civil Engineers, or Surveyors Institution. Local authorities, if written to, may say "Who are they, the members of this body? We know nothing of them." One of the points to be pressed forward, I think, is that we should be organised, and that powers should be got to obtain a charter. If we had one, a great many of the difficulties we labour under would be swept away. Persecution and pin pricks would be things of the past, and the Council could make protests with greater force. I think the district committees ought to do a great deal of good in many ways. The county associations have been very successful where they have been formed; because members have felt in the past that the Institution covered such a wide area that they could not get local representation, nor could they afford to travel great distances to the places where the meetings were held. I think it would be an advantage if arrangements could be made to reduce the areas still more. Not only would it be more convenient, but it

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would lead to greater *esprit de corps* among the members in each county. I think also that the point about saving trouble and expense in postages is a good one. Most of the meetings would be district meetings, and it should not be necessary to post these notices to every member throughout the country. The question of a paper to represent the Institution is rather a difficult one. I think we owe a debt of gratitude to the papers that cater for us now; and my opinion is that there are almost enough papers. It might be an advantage to run a paper solely for municipal engineers, but the project would certainly be a difficult one to carry through.

MR. WILLIS: What Mr. Campbell has written between the lines on the first page is what I wish to refer to particularly. I mean the question of unity. It is essential that we should get that before we try to secure a charter. We must endeavour to draw into our ranks all the young men, and most of the elder men now outside our organisation, even though they may not be the most highly qualified. If we could do that, the time might come when we should stand a chance of getting a charter; until then we shall not be successful. The Institution of Mechanical Engineers have not been able to get one; even the Institution of Electrical Engineers has been opposed. I think the terms on which the Institution of Civil Engineers admits members does not cover the whole ground for members of this Institution, and on that point I think we have a chance of success if we can be unanimous in future. Then there is a point about the district committees; that they are too large to give the amount of help we look forward to getting. With regard to the Author's observation, about the success of the county unit. I may say that in the association which I represent, we have members from four different counties, and there is among the members an *esprit de corps* which is most invigorating for a small but energetic association. I believe if these associations can be extended they will be a help to the Institution. I agree with the Author that there may be some waste, and some of this, I am of opinion, could be avoided. A helpful point would be for a list of meetings and visits to be published, if possible at the beginning of the session, and then members could make arrangements accordingly. It is probable we should have larger attendances if members had this information earlier than at present.

MR. BAINBRIDGE: My advice to you all is to be clear with

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regard to what you want, and to press your demands with determination. If you do that, there is not a Council in existence that will resist you. With regard to the attacks of which you complain, I think it is only right that if engineers are tackled through the press, the councillors themselves should come forward and back them up.

MR. HARPUR: I am sorry to strike a dissenting note. Mr. Campbell certainly goes over a good deal of ground, but I cannot see that he has broken any that is fresh. There is a lot of superficial talk in Mr. Campbell's paper, but I cannot see that it contains any practical suggestions for the district committees to work upon. I am afraid that if we follow the advice of entering into all kinds of discussions of business matters pertaining to the business of the Council at the meetings of the district committees, instead of getting that unity which Mr. Campbell suggests is essential for the good working of the Institution, we shall arouse an element of discord, and shall have different districts pulling different ways. That is a word of caution I wish to throw out in all seriousness. I do not like that the principles of Trade Unionism and Socialism should appear in our Institution, and I do not want the district committees to become dictators to their representatives and the Council. I do not agree with Mr. Campbell's suggestion of itinerant Councils. How can you conduct business properly without Secretarial records, documents, boxes, etc., to which reference has constantly to be made, and which could not conveniently be moved from place to place? We know that all the main lines of railway in the country lead to London; it is the place of all places that people can get to most conveniently, and most quickly. I should like to see a meeting of the Council held at Cardiff; but how many would be likely to get there? A meeting at Edinburgh might also be very desirable, but again, how many would attend? I doubt if you would succeed in getting a quorum either at Cardiff or at Edinburgh. I know something of certain Welsh Institutions which have tried the plan of meeting here and there, but they have decided that only meetings in the principal town are satisfactory. I hope that this question will not be brought up at any of the district meetings, as I feel sure the only result would be to let us down considerably as an Institution of importance.

THE PRESIDENT: I believe that the various district meetings

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will take the matter up in the right spirit. As a believer in the Institution as a whole, I have full confidence in the committees, and as satisfied that they will be loyal to the Council as a whole. I have not the least doubt that each district meeting will discuss the subject so as to arrive at an amicable arrangement for carrying out the work in the districts. I also believe that when we meet at the end of twelve months we shall meet in a spirit of congratulation, and that the district committees will have proved a thorough success, and been loyal to the Council, while improving our status, and stimulating interests in the objects of the Institution.

Mr. Campbell: I am not going to bore you. I will take an opportunity of replying more fully to the criticisms in writing. I have only one observation to make with respect to the dissentient note from Wales. We generally look to Wales nowadays for light and leading, but to-day Wales has struck a dissentient note, and has showered cold water which has brought no refreshment with it. I did hope for more than that; I had hoped Mr. Harpur would have contributed to our enlightenment rather than have derided the efforts of his colleagues on the Council.

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ANNUAL MEETING, 1912.

Visit to Aylesbury, July 13, 1912.

R. J. Thomas, M.Inst.C.E., President, *in the Chair.*

The members assembled in the District Council Rooms, where they were received by the chairman of the Bucks County Council (Mr. Tonman Mosley) and Mr. Nippin, the chairman of the Aylesbury District Council.

In welcoming the members, Mr. Tonman Mosley paid a warm tribute to the work of the President (Mr. R. J. Thomas) in his capacity as county surveyor, and alluded to the improvements of the highways which Mr. Thomas had effected.

Mr. Blair proposed a vote of thanks to Mr. Tonman Mosley and Mr. Nippin for their kind reception and welcome. This was seconded by Mr. Wike, supported by the President, and carried with acclamation.

MUNICIPAL WORK IN AYLESBURY.

By W. H. TAYLOR (*Member*),
Engineer and Surveyor to the U.D.C., Aylesbury.

Aylesbury is situated in the centre of Buckinghamshire, about 40 miles from London, on the London and Banbury road. It is the county town of Bucks, and gives its name to the large and fruitful Vale of Aylesbury, long celebrated for verdure and fertility.

The town was incorporated and made a Parliamentary borough by a charter from Queen Mary in 1553–54, but having

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by neglect lost its charter it is now under the control of an Urban District Council of eighteen members.

Statistics.—Area of Urban District, 3300 acres; population, 1901, 9244; 1911, 11,048; rateable, 53,979*l.*; number of inhabited houses, 2740; birth rate, 20·01; penny rate produces 203*l.* to the General District Fund; levels above Ordnance Datum, 240 feet to 304 feet.

Highways.—There are 8 miles of main roads and 6½ miles of other roads, and the County Council pay the Urban Council the sum of 1403*l.* per annum for the former. In respect to several of the principal other roads the County Council pay the Urban Council one half the cost of materials per annum. The surface of the roads over the railways and the approaches are repaired by the railway companies. Except several roads in the centre of the town, which are paved with setts, the main roads are all surfaced with granite, and below is a detailed cost of repairing High Street last year.

	£	s.	d.
135 tons of 2-inch granite, at 10*s.* 8*d.*	66	13	4
31 tons fine gravel, at 4*s.* 3*d.*	6	11	9
3700 gallons water, at 1*s.*	0	3	8
Labour, spreading granite, gravel, and sweeping for roller	4	9	7
Carting granite, gravel and water, for rolling	7	1	8
Steam rolling	6	11	8
	£91	11	8

Area coated 2044 super yards = 10·75*d.* per super yard.

With the exception of three or four, the other roads and side streets are surfaced with flints, and the following is the cost of repairing one last year:—

	£	s.	d.
97½ cube yards flints, at 6*s.* 10*d.*	33	6	8
15½ tons fine gravel, at 4*s.* 3*d.*	3	5	11
2600 gallons water, at 1*s.*	0	2	7
Labour, spreading flints, gravel, and sweeping for roller ..	2	18	0
Carting flints, gravel, and water	4	15	0
Steam rolling	3	15	0
	£48	2	9

Area coated 1260 super yards = 9·17*d.* per super yard.

Tarmac, etc.—In 1908 two short lengths of roads were laid down, one with tarmac and the other with tarvia binder. Both these roads are subject to heavy traffic, and for three years stood without any repairs being necessary. The cost was as follows:—

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TARMAC.

	£	s.	d.
92½ tons tarmac, at 14*s.* 11*d.*	68	19	10
Labour, spreading, etc.	3	2	4
Carting	4	17	4
Steam rolling	4	14	6
	£81	14	0

Area coated 1050 super yards = 18⅝*d.* per super yard.

TARVIA BINDER AND GRANITE.

	£	s.	d.
36½ tons binder	41	13	9
17½ barrels tarvia	11	3	7
53 tons 1 cwt. 2-inch granite	28	16	5
9 tons granite chippings	5	17	0
Labour spreading, etc.	7	17	11
Carting	6	13	11
Steam rolling	3	10	6
Sundry materials	0	6	5
	£105	19	6

Area coated 1355 super yards = 18¾*d.* per super yard.

The section of road laid down with the tarvia binder included a top-dressing of tarvia and granite chippings, and it being a little further from the station than the tarmac section, the carting was a little more costly.

Tar-painting.—In 1909 and 1910 only the main roads in the inhabited area were treated, but last year the whole of the main roads and several other roads were done, and it is proposed this year to do the same. The tar is carted from the local gas works in slop carts and applied to the road by means of a small spreader attached to a 50-gallon copper. The tar, after being applied to the road, is well brushed in by hand and clean Leighton sand sprinkled on the surface. Last year the cost was as follows:—

	£	s.	d.
20,231 gallons tar, at 1½*d.*	126	8	9
256 tons 9½ cwts. sand	43	15	1
7¾ tons granite chippings..	4	19	6
Brushes, fuel, etc.	9	9	5
Labour	91	13	3
Carting	21	18	6
Depreciation of tar boilers, etc.	5	15	6
	£304	0	0

Area treated 97·524 super yards = 0·748 pence per super yard.
Length 8·72 miles = 34*l.* 17*s.* 2*d.* per mile.

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The Author has found treating the roads with tar not only prevents the dust nuisance to a considerable extent, but also prolongs the life of the road very considerably.

Private Street Works.—The Private Street Works Act, 1892, has been adopted and several streets have been made up under this Act during the last two years. The cost of these streets was 9*s.* 7*d.* per lineal foot, including soil sewers, manholes, gullies, 6 inches of hardcore and 6 inches of flints on carriage-way, sett channelling on lime concrete, 5-inch by 10-inch stone kerb on lime concrete, and 3 inches tar-paved footways on 6-inch brick rubble. The average cost of these works was as follows:—

	£	s.	d.
Soil sewers, 9 inches diameter, 6 feet deep, per lineal foot	0	1	11
Gully pans, iron frame and grating, including connection to sewer, each	3	18	0
Manholes in 9-inch brickwork, 5 feet by 2 feet 6 inches, and 6 feet 6 inches deep, with covers complete, each	9	17	0
5-inch by 10-inch stone kerb, on 4 inches lime concrete, per lineal yard	0	4	0
4-inch by 4-inch stone sett channel on 4 inches lime concrete, per super yard	0	8	6
4-inch by 4-inch stone sett crossings on 6 inches lime concrete, per super yard	0	9	1
6 inches thick stone hardcore hand packed, per super yard	0	1	0
6 inches thick flints, including rolling, per super yard..	0	1	8
3 inches thick tar-paving	0	2	3

Concrete Kerb and Channel.—The Author has experimented making concrete kerb and channel blocks in wood moulds. They turned out very satisfactorily, and one length has been laid. The kerb and channel blocks were made with Portland cement and ¼-inch to dust Clee Hill granite chippings 1 to 3. The kerbs are 5 inches by 10 inches, 3 feet long, and the blocks 9 inches wide (slightly dished), 15 inches long, and 4 inches thick, and cost to make 5*d.* and 3*d.* per foot respectively. When laid complete on 4 inches of cement concrete and the blocks protected by one row of 4-inch by 4-inch setts, the cost worked out as follows:—

	s.	d.
5-inch by 10-inch concrete kerb on 4 inches cement concrete per lineal foot	0	10½
9-inch by 4-inch concrete channel block, on 4 inches cement concrete, including one row of 4-inch by 4-inch setts, per super yard ..	8	9

Highway Yard and Depôt.—The town's yard is in Cambridge Street in a very central position, and comprises stabling for eight horses, steam roller, cart and materials shed, office, stores, workshop and mess-room for workmen. The land, one-half an acre together with five small cottages, cost 700*l.*, and

the buildings, etc., 1893*l.*, total, 2593*l.* Six horses are owned by the Council at the present time, and team labour can be hired for 6*s.* 6*d.* per day for horse and driver. The cost of keeping the Council's horses last year was as follows:—

	£	s.	d.
Fodder	190	14	2
Shoeing	12	19	11
Repairs to carts, harness, etc.	71	13	2
Rent of field	21	12	0
Rent of stables (say)	40	0	0
	£336	19	3

Average number of horses 5·67, cost per horse per week = 1*l.* 2*s.* 10*d.*

Street Lighting.—The street lighting is carried out by the Council, and the cost last year worked out as follows:—

	Flat flame burner.			No. 4 Kern burner.			Large incand. burner.		
	£	s.	d.	£	s.	d.	£	s.	d.
Gas	1	13	4	1	15	0	4	0	0
Mantles		—		0	1	4½	0	3	1
Globes		—		0	0	6	0	3	7
Sundries	0	1	0	0	1	8½	0	1	8½
Lighting and extinguishing ..	0	8	9	0	8	9	0	8	9
Labour for repairs	0	3	0	0	4	0	0	4	0
Cost per lantern per annum	£2	6	1	£2	11	4	£5	1	1½

Number of mantles used per lantern per annum ..	7	7
" globes " " " " ..	3·1	3·2
Cost of gas 3*s.* 4*d.* per 1000 cubic feet.		
Number of hours lanterns burning per annum		1792

The lanterns on the outskirts of the town are fitted with Gunning's Automatic Lighting and Extinguishing apparatus, and give every satisfaction. The lanterns have been gradually converted from flat flame burners to incandescent burners, out of current rate.

Public Baths.—The public baths are situated in Bourbon Street, and were presented to the town in 1895 by the late Baron Rothschild of Waddesdon Manor. They are open only during the summer months, and consist of a swimming bath, 60 feet by 20 feet, and nine private slipper baths. The price of admission to the swimming bath varies from 3*d.* to 1*d.*, according to the day, and the slipper baths 3*d.* first class and 2*d.* second class. Last year the swimming bath was used by 11,375 persons, and the slipper baths by 4334 persons; total, 15,709; and the loss on the year's working was 136*l.*

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Sewage Disposal Works.—The sewage disposal works are situated about one and a quarter miles north of the town, consisting of a screening chamber, five open settling tanks, twelve contact beds, two storm-water filter beds, twelve acres of land, and pumping and sludge pressing plant.

Flow.—The lowest flow during the hot summer of 1911 was 226,000 gallons in twenty-four hours.

Tanks.—The five tanks have a total capacity of 305,000 gallons, three 35,000 gallons each, and two 100,000 gallons each. Two small tanks and one large one are used during the day, one small tank being kept for the night flow and the remaining large tank is kept empty in case of a storm.

Contact Beds.—During fine weather the beds are used on the double contact system, and each have a working capacity of about 25,000 gallons. The media averages 3 feet deep, and consists of 1 foot of fairly large clinker, and 2 feet of coke breeze and clinker, 1 to 1½-inch gauge.

Storm-water Filters.—The two storm-water filter beds were constructed for contact beds, but they are used as continuous filters, and hold 50,000 gallons each. The media is burnt ballast, average 3 feet 6 inches deep.

Land.—The bed effluent is pumped on the land, which is divided into six sections, and fed by a channel running the whole length of the field. The land is not underdrained, and the subsoil is clay.

Pumping Plant.—The bed effluent and storm water gravitates to the pump house, and is pumped on to the land and storm beds by means of centrifugal pumps driven by gas engines.

Sludge Pressing.—The sludge gravitates from the settling tanks into a well in the pump house, and then lifted by means of a 5-inch Tangyes sludge into a large tank on the top of the building. Ground greystone lime is then added, and the sludge pressed by two Manlove Alliott and Co. sludge presses. The cake is carted away from the works by farmers, but during the summer it is difficult to dispose of.

Bed Washing.—The contact beds are washed every three to four years. The washing is done by means of a portable engine, and one of Messrs. Hughes and Lancaster's revolving washers. The cost of emptying, washing, and refilling, including new clinker, and a certain amount of new coke breeze works out at 4*s.* per cube yard.

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Effluent.—The result of the last analysis made by the county analyst, Mr. W. W. Fisher, is as follows:

Expressed in Grains per Gallon.

Total solid matter in suspension	Negligible.
Total dissolved solid matter	49·0
Chlorine as chlorides	6·0
Ammonia free and saline	0·756
Albuminoid ammonia	0·053
Nitrogen as nitrates and nitrates	0·21
Oxygen absorbed by organic matter in 3 hours ..	0·407

DISCUSSION.

Mr. C. Vawser: With regard to tar painting Mr. Taylor states the cost of the work is 0·748*d.* per super yard. I should like to congratulate him on being able to do it at so low a cost. Secondly, with regard to the private street works Mr. Taylor states that kerbs 5 inches by 10 inches on 4 inches cement concrete cost 10½*d.* per lineal foot. I would like to know what kind of stone he uses. At the bottom of average costs Mr. Taylor gives us 3 inches thick tar paving 2*s.* 3*d.* He does not state whether that includes the foundation or whether it has any foundation underneath. As to street lighting, Mr. Taylor gives us the cost of the change from flat-flame burners to the No. 4 Kern and large incandescent burners, but he does not give the increased illuminating power of the incandescent over the flat-flame burner. Then, as regards the sludge pressing, Mr. Taylor states that the cake is carted away from the works by farmers, but during the summer it is difficult to dispose of. I would like to know whether it is found of fertilising value, and why it is difficult to dispose of.

Mr. G. W. Lacey: I have great pleasure in seconding the vote of thanks to Mr. Taylor for the paper. It is full of practical information, particularly to those who occupy similar positions in towns of similar size to Aylesbury. In looking through the statistics of road work the cost of granite at 10·75*d.* per yard super is very low. We have to take that into consideration with the fact that labour and haulage is lower here than in many other places. I would like to ask what are the rates of wages for labouring work? The rate of haulage 6*s.* 6*d.* per day is a very low one. I see, in working out the number of yards coated with 135 tons of granite, it really means a coating of only

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2 inches; that is rather a light coating, and accounts for the comparative cost being low. With regard to the tarmac, Mr. Taylor gets that done also at a very cheap rate—1*s.* 6¾*d.* per super yard. I take it that his preparatory work, steam rolling, etc., must be very light indeed. With regard to tar painting I see that he uses crude tar, and it is rather a point to be noted that in many places the use of ordinary gas tar appears to meet with a considerable measure of success. Many of us have been rather afraid to use crude tar on account of its varying quality, and have fallen back upon the dearer distilled tar and other proprietary articles, and it is impossible to do the work for the price it is done at in Aylesbury. I notice he uses sand for blinding over the tar. From what I have seen it is much more difficult to evenly spread sand. It is likely to fall in lumps and cake with the tar, and form patches. I would like to know what has been Mr. Taylor's experience and what would be the extra cost of granite chippings as compared with sand? The information with regard to private street works is very useful. With regard to street lighting the number of hours per annum is very low; so I take it the lamps are cut off on moonlight nights or on certain roads. I would like to know as to the burners, whether they are double burners at 2*l.* 6*s.* 1*d.* per annum. We get double incandescent burners for 4*l.* per annum, with 3400 lighting hours. With regard to the sewage disposal works the result of the final effluent is very good; but as a matter of comparison I think one would like to know what results are obtained from the contact beds before the effluent is finally treated on the land. If that could be given it would be useful to us as showing what the results are from the first part of the process. I find at my sewage works, which have not been long completed, my people are apt to look at the results of the first part of the system and judge thereupon, and though in my case the filters are of a small area compared with the quantity to be treated thereon, because of having a final treatment on land, the effluent, while as good as can be expected, is not perfect, but the final results are very comparable to those obtained by Mr. Taylor.

Mr. E. J. Elford: I should like to ask why flints are used when granite can be provided for 1½*d.* per yard more.

The President: I will put this motion, and in doing so I would like to add my small meed of praise to Mr. Taylor for

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the way in which he maintains his main roads for our County Council. There has been a very distinct improvement in these roads of later years, and not at a very great increase in cost. Increase there must be. The cost of roads is going up, must go up, and the most economical system at starting may often prove the most expensive in the end. Mr. Taylor and I have worked together for years, always in harmony, and I hope always will. I therefore put the vote of thanks to Mr. Taylor for his paper.

The vote of thanks having been unanimously accorded,

Mr. W. H. Taylor, in reply, said: I am very much obliged to Mr. Vawser and the other speakers for their kindly reception of my paper, and will reply briefly to the questions asked. As to the stone kerb, we use Bristol pamant. It is brought to the town for 10½*d.* The tar-paving at 2*s.* 6*d.* per yard only includes the paving, not the 6 inches of rubble underneath. The No. 4 Kern burner gives a candle-power of 120, average 80, and the large incandescent burners 150 to 170 candles. As to the pressed sludge cake, the farmers cart it away free of cost to the Council, but during the haytime and harvest we have difficulty in getting rid of it, because the farmers are too busy to send for it. The granite coating averages 2 inches to 2½ inches thick. The rate of wages to labourers in Aylesbury is 18*s.* per week, 3*s.* per day. As to the use of sand on tar-painted roads, I should prefer to use granite chippings, but the cost is much larger, and the great thing is to keep down the cost. As to contact beds, I will send Mr. Lacey the information for which he asked. As to flints, we have only a few side streets paved with these, and gradually granite is superseding flints. As to horse-keep. As against the 6*s.* 6*d.* per day for hired horses, our cost is 1*l.* 2*s.* 10*d.* per week for each horse. Then we get the work better done with our own horses. The consumption of the flat-flame burners averages about five feet per hour, and my experience of the No. 4 Kern burner is that I have not been able to get it below 5 feet per hour.

The President proposed a hearty vote of thanks to the District Council for the use of the hall for the meeting, which was unanimously accorded.

The Members then proceeded in motor cars for an inspection of the county roads.

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The President supplied the following notes upon the roads inspected:—

The roads in the neighbourhood of Aylesbury are not amongst the most important or expensive the Bucks County Council has to maintain, but are country roads, having traffic typical of that to be met with in agricultural districts, including, however, traction engines and heavy commercial motors, also a considerable number of light motors.

In such a county, having a large mileage of main roads, with but a small rateable value, where 100*l.* per mile represents a 1*s.* rate, financial considerations play a considerable part in determining the methods to be employed in dealing with the road problem, especially as the staple industry, agriculture, is not in a flourishing condition. Efforts have therefore been directed towards ascertaining the cheapest methods of obtaining surfaces capable of withstanding the modern traffic using these roads, and the policy adopted has been to tar-paint a large mileage of important roads, as this extends the life of the metalled surface, and so makes it financially possible to gradually surface the trunk roads with bituminously bound material. It is quite appreciated that in the case of large towns and important suburban roads more expensive and elaborate methods may be essential.

The Aylesbury, Wendover, and London Road has daily traffic averaging 72 tons per yard width, the central 6 feet 6 inches bearing 125 tons per yard, and the remainder 45 tons per yard. Roads inspected:—

In Aylesbury Urban District.

Tarvia and granite laid on the Gladwell system by Mr. W. H. Taylor, the Aylesbury surveyor, who gives details in his paper.

Bucks County Council.

1. Clee Hill basalt, bought ready mixed with refined tar and some pitch, laid in December, 1910, a layer of 2-inch gauge, spread 2½ inches thick, partly rolled, topped with 1 inch, and consolidation completed to 3 inches. Cost, 2*s.* per square yard; area covered per ton, 10 square yards. No surface tarring necessary until April last. Small repairs in ½-inch material effected recently along centre. The previous surface was Groby granite, some 1½ inch thick, upon the old flint road, which was converted into granite some five years ago.

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2. Clee Hill basalt, bought ready mixed with refined tar and some natural asphalte, 2-inch and 1-inch gauges, mixed in proportion of 66 and 34 per cent., spread 3½ inches thick on old surface (freshly tarred) and partly consolidated, ½ inch tarred Clee Hill added, and the whole consolidated to 3 inches. Laid in June. Cost, 2*s.* 1*d.* per square yard; area covered per ton, 10 square yards.

3. Groby granite, 2-inch gauge, spread 2½ inches thick, consolidated to 2 inches in January, 1912, a ton covering 14 square yards. Cost, 1*s.* per square yard. Well brushed in April and painted with crude tar, applied hot from portable boilers, thoroughly brushed into the interstices. Cost, 0·66*d.* per square yard.

Note.—In agricultural districts it is essential to avoid constructing surfaces so smooth that under certain climatic conditions horses cannot obtain a foothold, so the tarring on the surface of these roads has been kept as thin as possible, consistent with the adequate penetration into the interstices to secure the complete sealing of the material against penetration of water.

4. Similar to No. 3, but laid in April, 1910, to a width of 11 feet along centre on the old flint road. Tar-painted on the granite only in 1910 and 1911; over full width of road April, 1912.

5. Similar to No. 4, but no tarring done since May, 1911. This portion is left to show the durability of surface-tarring, which has withstood a summer and winter.

Tring and Aylesbury Road.

6. Another instance of granite surface over old flint and dressed with boiling tar.

In Aylesbury Urban District.

Tarmac laid by Mr. W. H. Taylor, the town surveyor, and described in his paper.

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EASTERN DISTRICT. MEETING AT GRAYS.

September 21, 1912.

Held in the Council Offices, Grays, Essex.

R. J. THOMAS, M.INST.C.E., PRESIDENT, *in the Chair.*

MR. T. M. BANKS, Vice-chairman of the Urban District Council, in the unavoidable absence of the Chairman, Mr. H. E. Brook, J.P., received and heartily welcomed the Members of the Institution.

A hearty vote of thanks to the Vice-chairman for his kind reception was proposed by the President, seconded by Mr. Willis and carried unanimously.

The following twelve members were elected to serve on the Executive Committee of the District: Messrs. C. Brown, S. H. Chambers, Harold Collins, A. Gladwell, P. T. Harrison, W. R. Hicks, W. H. Prescott, J. E. Sharpe, C. Vawser, H. T. Wakelam, H. F. Wilkinson, and E. Willis.

The following paper was discussed.

THE MUNICIPAL WORKS OF GRAYS.

BY ARTHUR C. JAMES, ASSOC.M.INST.C.E. (*Member*),
SURVEYOR TO THE URBAN DISTRICT COUNCIL.

THE history of Grays Thurrock goes back for many centuries. Its name, Thurrock, is a corruption of Thor's Oak, reminiscent

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of a druidical worship under the oak trees of the neighbourhood. Harold, the last of the Saxon kings, was Lord of the Manor of the middle part of Thurrock. Grays, the name by which the town is now known, except for official purposes, was added by the grant of the manor of Thurrock to Henry de Grey by Richard I. in 1194, the grant being confirmed by John in 1199. The original grants are still in existence, and facsimile copies are hung in the Free Library.

The municipal history of the district dates from 1886, when the local board was formed. Before the construction of Tilbury Docks, Grays was little more than a river-side port for the conveyance of agricultural and other produce to and from the surrounding countryside. There were also extensive chalk quarries and, later, the cement industry found employment for a considerable number of men. The docks were commenced in 1882 and opened in 1886, and the population increased from 5327 at the census of 1881 to 11,199 in 1891, the town becoming the residential and shopping centre of the district. At the census of 1911 the population was 15,998, and the rateable value is 51,062*l.*, or only 3*l.* 3*s.* 10*d.* per head of the population. When the low rateable value per head, and the fact that the district is a new one in which the needs of modern urban life have had to be provided for within the last twenty years, so that few of the loans have yet fallen in, are considered, it is not surprising that the general district rate is 4*s.* 4*d.* in the £. The poverty of the place has permitted little expenditure except for necessaries, but the Author trusts that members may find something of interest in the following brief description of the work which has been carried out.

The district is approximately 2¼ miles from north to south, 1¾ miles in width, and the land area is 1382 acres. The levels range from 6 feet above O.D. in the south to 115 feet above O.D. in the north-west. The low-lying land adjoining the Thames is alluvium, and much of it is below high-water level, being protected by the river wall, for which the Essex Sewers Commissioners are responsible. The higher ground consists chiefly of gravel beds overlying the chalk. The death rate for 1911 was 10·7 per 1000, only three deaths being attributable to infectious disease.

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Sewerage and Sewage Disposal.

The first task of the Local Board was the provision of a system of sewerage, the town then being entirely drained into cesspools which were not watertight. Designs for schemes were invited and that of Mr. W. H. Radford, A.M.I.C.E., of Nottingham, was selected. Work was commenced in August, 1892, and the disposal works were brought into use in November, 1894, the cost being 42,000*l.* The scheme is designed on the partially separate system, all rain water from streets and front roofs being taken by surface water drains to four main outfalls. The sewers are laid chiefly in the back roads, with which all streets are provided, and receive all yard and back roof drainage in addition to the sewage proper. A system of ventilation by means of columns 30 and 40 feet high was installed in 1902. The disposal works are placed on the marsh land in the southern part of the district, where all the sewage is pumped and treated. The sewage from Chadwell St. Mary (now the recently formed Urban District of Tilbury) and Little Thurrock, two parishes in the Orsett rural district, also drains to the works, being pumped and treated by the Grays Council under agreement. The average daily flow to the works last year was 238,000 gallons from Grays and 233,000 gallons from Tilbury and Little Thurrock. The dry weather flow from Grays is about 11 gallons per head.

Originally the works were designed for the treatment of the sewage by chemical precipitation, but in 1902 the precipitation tanks were converted into septic tanks and new bacteria beds constructed at a cost of 4500*l.* The original tanks cracked considerably owing to bad foundations; the walls and floors of the new beds were therefore reinforced with old railway metals and no cracking has been experienced.

The works do not present any features of special interest. Daily records of the quantities of sewage pumped have been kept since the works were opened, and some years ago the Author had occasion to extract details of the daily flow over a period of eleven years, particulars of which may be found useful, as they bear upon the requirements of the Local Government Board for new works. It was found that the increase in the dry weather flow due to rainfall was as follows:—

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Exceeding once, but not exceeding		$1\frac{1}{2}$ times the D.W.F.		..	562 times.
"	$1\frac{1}{2}$ times "	"	2 " "	..	125 "
"	2 " "	"	3 " "	..	43 "
"	3 " "	"	$3\frac{1}{2}$ " "	..	8 "
"	$3\frac{1}{2}$ " "	"	4 " "	..	once.
"	4 " "	"	$4\frac{1}{2}$ " "	..	once.
"	$4\frac{1}{2}$ " "	"	5 " "	..	once.
"	5 " ..	..	.. .. ..	..	never.

It will be seen that the total daily flow exceeded twice the D.W.F. only on 54 occasions in eleven years.

For some years there has been a proposal before the district for the provision of a joint outfall sewer for West Thurrock and Stifford, to the west of Grays, as well as the three parishes now using the Grays works, with new disposal works below Tilbury. A provisional order forming a joint sewerage board for this purpose has recently received Parliamentary approval.

Surface Water Drainage.

Owing to the low level of portions of the district the disposal of surface water is an expensive matter. For one portion of the town a tank to contain the rain falling at high water had to be provided, its contents being discharged to the river at about half tide. The centre of the town, which drains to a tidal ditch, was subject to considerable flooding and a new 30-inch drain was constructed in 1904 at a cost of 3550*l.*, by which a large part of the drainage was diverted from that outfall. This proved still to be insufficient, and recently further works were undertaken at a cost of 2230*l.*, which included the provision of electrically driven centrifugal pumps to discharge the flow direct to the river at high tide. The rising main from the pumps is about a quarter of a mile long, and is constructed of Siegwarts' reinforced concrete pipes. The Author has lately presented a report upon flooding in other parts of the town, recommending certain works estimated to cost 4100*l.*, pumping being necessary at two outfalls.

Scavenging and House Refuse Collection.

About nine miles of streets are regularly scavenged either daily or two or three times weekly as required, and the main shopping streets are swept twice daily. The sweepings are taken to a farm in the district, but, since the advent of surface tarring, the farmer finds they are useless as manure. The annual expenditure is about 670*l.* Formerly the house refuse was carted

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to any convenient tip, but in 1901 a destructor was provided in connection with the electric lighting station then being built. The plant consists of a Meldrum Simplex twin cell and Lancashire boiler, the steam being utilised by the electricity department. The destructor is placed in the centre of the district, 300 yards from the Council offices, and the cost was 3284*l.*, including fencing the land and heavy foundations necessitated by the character of the site. The refuse is collected once weekly in covered carts containing 2½ cubic yards, and the cost is 3*s.* per load or 3*s.* 6*d.* per house per annum. Trade refuse is not collected, but is received and burnt free of charge. The clinker has been largely used for making up back roads and other purposes, and finds a ready sale at 1*s.* per load, the income from this and from the sale of old tins being about 60*l.* per annum.

Parks.

In 1898 the Council purchased 8¼ acres of land in the centre of the district at a cost of 2100*l.* Of this, 1¼ acres were set apart for a depôt, and the balance laid out as a public recreation ground. Stabling, etc., was at the same time erected in the depôt, the total expenditure on the scheme being 3400*l.* Further buildings have since been erected at a cost of 850*l.* Though small, the park forms a useful open space, which would otherwise undoubtedly have been occupied by cottages ere this. Attention may be called to the use of concrete in the boundary walls where appearance is not material. This wall, 6 feet 6 inches high, cost only 8*s.* 6*d.* per yard, including foundations, and there has been no expense for maintenance. Ivy is planted against the wall, forming a good background for the gardens and shrubs.

In 1903 the Council purchased 4¾ acres of land adjoining the river Thames for 1880*l.*, and the owner gave 1 acre as a memorial of the coronation of King Edward VII. The land is situated on both sides of the river wall, and the part next the river has been filled up and covered with Thames ballast and sand to form a beach, and the ground is known as "The Beach." This was not done, as was widely assumed at the time, with the idea of making Grays a seaside place, but as an economical method of rendering useful land which is covered by the river at spring tides. It is much appreciated by the children of the neighbourhood who make use of it in large numbers during the summer. On the land side of the river wall, which is about eight feet lower than the

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wall, it was proposed to construct a model yachting pond, and the plans also provided for an enclosed open air swimming bath. The Local Government Board declined, however, to sanction a loan for the latter. When work was begun, the Sewers Commissioners issued an order for the river wall to be raised 18 inches, and it was, therefore, determined to deepen the pond in order to provide the necessary soil for raising the wall, and at the same time make the pond available for swimming. Water is supplied to and removed from the pond at spring tides by a 21-inch pipe communicating with the river by way of the surface water storage tank above referred. The cost of a special communication with the river was thus avoided. Although the bottom was only of mud, the bathing proved such an attraction, that in the autumn of 1905, it was decided to deepen the pond, line it with concrete, erect dressing sheds, and provide a well and pump to supply fresh water. The concrete bottom is only 6 inches thick, and is reinforced with wire netting. The walls round the pond are of the same thickness, reinforced with wire. The pond is 90 yards long by 50 yards wide. It is 1 foot 9 inches deep at the sides, sloping towards the centre, where there is a portion 70 feet by 30 feet in front of the diving stage, which is from 6 feet 6 inches to 6 feet 9 inches deep. A refreshment kiosk was at the same time built, the shop being at the level of the river wall, while beneath it are a store for model yachts and conveniences for both sexes. Altogether 4500*l.* has been spent on this work. The pond is open for bathing daily during the summer months, from 6 a.m. to 9 a.m., and from 6 p.m. till sunset, at a charge of 1*d.*, and 2*d.* is charged for a private dressing box. Ladies are admitted free from 9 to 11 daily, and boys of school age from 9 till noon on Saturdays. On other days the boys from the elementary schools have the use of the pond for swimming instruction.

Cemeteries.

The Council act as the Burial Board, and possess two cemeteries, one adjoining the church in the town, and the other in the parish of Little Thurrock about one and a half miles distant. This was purchased and laid out thirty years ago. In 1900 the council purchased 7½ acres of land adjoining the Little Thurrock Cemetery for the purpose of extension, and this has been fenced and partially laid out to find work for unemployed. The fence

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consists of about half a mile of concrete wall similar to that at the park, but rendered on the outside, where it adjoins a public road.

Workmen's Dwellings.

In 1901, twenty-five cottages were erected in Parker Road. The cottages contain parlour, kitchen, scullery, larder, and three bedrooms, and the contract price was 5250*l.* The cost of the land was 272*l.*, and that of roads and sewers, 206*l.* 10*s.* The cottages were first let at 8*s.* per week, afterwards reduced to 7*s.* 6*d.*, and again, three years ago, when many of the houses in the town were empty, to 6*s.* 6*d.* At 7*s.* 6*d.* per week the houses might pay their way, but at 6*s.* 6*d.* this is impossible, and there is a considerable debit balance on the account.

Lighting.

An electric lighting scheme for the district was carried out in 1901 by Messrs. Preece and Cardew, and since its completion in October of that year, the town has been entirely lighted by electricity. There are 284 public lamps, the candle power ranging from 50 to 400, with an average of 70 candle power. The price of current for public lighting last year averaged 3·1*d.* per unit. For private lighting the price of current is from 4½*d.* to 3*d.*, according to the quantity consumed, the average price received being 3¾*d.* For power the charge is 2½*d.* per unit, and motors equivalent to 294 horse-power are supplied. The undertaking makes a small nett profit, after payment of all charges.

Highways.

The main roads of the district are 2 miles 7 furlongs in length, and are maintained by the Council, contracts being entered into from time to time with the County Council, for periods of five years. The annual sums paid have been: 1896–1906, 1140*l.*; 1906–1911, 900*l.*; current contract, 950*l.* For special improvements extra payments are made. It will be seen that the large increase in the cost of maintenance which has been experienced elsewhere, owing to the advent of motor traffic, has not obtained here, although there is a very considerable motor traffic, both heavy and light, through the district between London and Southend, and to Tilbury Docks.

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Some five and a half miles of private streets have been made up during the Author's term of office, the specification being as follows:—

Carriageways.—Nine-inch chalk flint foundation and 4-inch hand-broken chalk flint surface.

Footways.—*In sitû* concrete, composed of 3-inch Thames ballast concrete, faced with 1-inch granite concrete (cost 3*s.* per square yard).

Kerbs.—Straight; 12-inch by 8-inch concrete, similar to the footway, formed *in sitû* (cost 1*s.* 6*d.* per yard); circular, 12-inch by 8-inch granite.

Channels and Crossings.—Formerly of granite setts on concrete, but latterly of scoriae bricks.

The price of flints has largely increased of late, and on the last streets made up the carriageway construction was varied to 4-inch destructor clinker, 6-inch flints, and 3-inch granite macadam, without extra cost. Most of the streets in the district are 40 feet wide, and the average cost is about 10*s.* 6*d.* per foot of frontage. Formerly, none of the streets were channelled, but the Author persuaded the Council to include this work when the first batch of private streets was taken in hand. It was afterwards decided to channel all the existing roads. In all, 11½ miles of kerbs, 17¾ miles of channels, and 9½ acres of footway paving have been laid down since the Author's appointment. Very considerable improvements have been effected to existing roads, some two acres of land having been added to the highways. Advantage was taken of the opportunity when widening a road to strengthen the foundation of the road dealt with over its total width, and it is to this that the fact that maintenance costs have not increased is in large measure to be attributed. For many years granite chippings have been used in binding road surfaces, and it is the practice when re-surfacing a road to remove all the small scarified material which, when sifted, is used for repairs in streets of less traffic, and for patching.

Surface tarring was first tried experimentally in 1905, and since 1906 all streets have been tarred annually without any addition to the total expenditure. The cost of watering has been reduced from 240*l.* per annum to an average of 38*l.*, while the quantity of mud removed during the winter and the contents of street gullies has decreased 45 per cent. It is certain that both of these items would have been largely increased as a

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consequence of the motor traffic, had not this or some similar treatment been adopted. Crude tar has for several years been applied by machine at a cost of 0·42*d.* per square yard, with tar at 2*d.* per gallon, sand 2*s.* 6*d.* per yard at the pit, horse hire 8*s.* per day, and labour 6*d.* per hour. This cost includes the special preliminary scavenging and foreman's wages. This year de-hydrated tar at 2½*d.* per gallon has been used, while horse hire has risen to 9*s.* per day and labour to 7*d.* per hour. Several lengths of macadam grouted with bituminous material have been laid down, the following materials having been used:—crude tar, tar and pitch, roadoleum, natural asphalt matrix, asphaltmac and camarco. Until the last two years 1½-inch macadam has been employed, it being found to give a smoother surface than larger stone and to minimise the wheel friction with the result that less dust is created. With the advent of heavy motor traction 2-inch stone has been substituted on the roads of heaviest traffic, but the Author is of opinion that with bituminous binders 1½-inch material is preferable.

While dealing with the subject of highways, the Author would like to emphasise the importance of standardising materials, especially macadam. Samples sent with tenders are generally well broken and of the specified sizes, but to judge by the character of subsequent deliveries, must sometimes have taken a considerable time to find. Having had to reject a good many cargoes of stone on account of bad breaking, the Author knows from experience how difficult it is to convince some contractors that when "cubically broken" stone is specified, it is of any consequence that it should be supplied. The rejection of a ship's cargo of 200 tons is a serious matter both for the contractor and the council, and it is sincerely to be hoped that practical good may result from the efforts of the Standardisation Committee of the Institution in this direction.

Conclusion.

The whole of the works above described, with the exception of the sewerage scheme as originally designed, and the electric lighting scheme have been designed and carried out under the Author's supervision by the direct employment of labour, contractors only being employed for the erection of buildings.

The Fire Station, in Orsett Road, was designed by the Author's predecessor, the late Mr. Chas. Cobham, F.S.I., and

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erected in 1892 at a cost of 1500*l.* The Free Library in Orsett Road was built in 1903, at a cost of 3000*l.*, provided by Mr. Andrew Carnegie, from the designs of Mr. C. M. Shiner, A.R.I.B.A., of Grays.

DISCUSSION.

MR. H. PERCY BOULNOIS: I should like to congratulate Mr. James on this paper, which is very concise and quite to the point. It gives an admirable epitome of the work he has carried out. Referring to the table giving the number of times the flow in the sewers has exceeded one and a half times the dry-weather flow up to five and six times the dry-weather flow, I consider that table very valuable, and I wish a similar record was more generally kept. The Local Government Board have overflows put in the sewers when six times the dry-weather flow has been reached. In this case six times the dry-weather flow has never been reached, five times has only been reached once, four and a half and four times only once each. I have the greatest possible pleasure in moving a vote of thanks to Mr. James for preparing this paper.

MR. E. WILLIS: With regard to the levels of the district, I notice they range from 6 feet above O.D. in the south to 115 feet above O.D. in the north-west. I think this is very fortunate for the district because the hills, being of chalk, can be gradually reduced, and thus form an asset. As to the surface-water drainage, I should like to ask Mr. James whether he has had any very serious difficulty with floodings. He mentions that he has had some difficulty, but does not say whether it has been serious. I have had the tide running up a surface-water culvert in the centre of my district, and have had to carry the water away by the sewers. As to the collection of house refuse, I see it is done by 2½ cubic yard vans. Is that the most economical? I started with vans of 3 cubic yards, and have gone up to 6 cubic yards. It happens that my district is very flat, and that is why I am able to use such large vans. By that means we have steadily reduced the cost of house-refuse collection, in spite of the gradual increase in the population of the district, and without any apparent additional wear and tear on the horses. Under the clause dealing with highways, there is one thing the Author is to be very much congratulated upon, viz. that in spite of the increase in

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motor traffic the current contract for the main roads of the district is 200*l.* less than in 1906. That seems remarkably good, and I think it is a matter for hearty congratulation. May I also seek information with regard to the footways constructed with "in situ concrete," at a cost of 3*s.* per square yard? I have personally had some little experience with concrete footpaths, but where trenches have been cut through them, I can never repair them as well as I should wish. In the extra Metropolitan Districts we get a number of trenches opened by the various companies having statutory powers, which cut up the footpaths in a most unsatisfactory manner. I should also like to have some information as to the wear of concrete kerbs. I have had no personal experience with them, but if they wear well it might be worth while considering their use in the future. I would also like to refer to the surface tarring and the extreme economy in watering. I do not know whether that has been universal with the members, but it has not been my experience. I have tarred miles of roads in my district, but the watering bill has not been reduced very much. The residents in my district do not appreciate even a tarred slag road which has not been watered at all. Possibly some of the other members present might give their experience upon one or more of the matters previously referred to.

Mr. E. R. Capon: I should like to ask as to the price of tar, which is not stated in the paper, and the area of roadway covered per gallon. The cost of tar painting comes out at a very low price. I certainly cannot touch it. My cost is from 1¼*d.* to 1¾*d.* per yard according to the localities. As to the carriageways, I notice there is only 4 inches of flints on the surface. I would like to ask how long it lasts. As to the concrete kerb, I should like to ask how it wears. It is very economical, if you can get it to stand.

Mr. E. J. Elford: I am sure the Council of the Institution will appreciate the way in which this paper has been prepared. If all papers were written in the same concise business-like way the printing bill of the Institution would be very much reduced, and I do not think they would lose very much in usefulness. The impression I have obtained is that Mr. James does his work remarkably well and economically. He has not the scope here that those in larger districts have, but what he has had to do he appears to have done in a highly creditable manner. I should

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like, if I am in order, to ask Mr. Willis the weight of his 6-yard vans. That is a rather important point. I find that the weight of very large vans very much reduces their usefulness.

Mr. E. Willis: The tare is just over a ton.

Mr. Elford: The cost of house refuse collection appears to be very low. Mr. James says the plans for the enclosed open-air swimming bath were not approved by the Local Government Board. It would be very interesting to know why. Altogether 4500*l*. has been spent on the refreshment kiosk, store for model yachts, conveniences, and bath. Has that been paid for out of loan or revenue? The fact that a profit is being made out of the electric-lighting undertaking is, I think, very creditable for so small an undertaking. I notice Mr. James has not yet commenced to use tar macadam or other similar material for private street works, but I think we shall all have to come to that, and probably the cost will not be very much greater than at present. Mr. James uses 1½-inch macadam on most of his roads, subject to the heavier traffic. Personally I favour the use of 1½-inch stone everywhere, including roads subject to heavy traction traffic. I think a good road made with 1½-inch stone is more satisfactory than a road made with a larger material.

Mr. S. H. Chambers: I should like to add my thanks to the Author for the valuable and interesting paper, and to ask him what the water supply per head is in this district. It would appear that the volume per head of sewage flow is abnormally low. I do not think there are many districts which keep to so low a quantity. It is very interesting to see the particulars of flows given, but I think it must be in a very dry neighbourhood, seeing that at the present time the average flow is only some 15 gallons per head per day. With regard to the cost of watering I should like to ask whether Mr. James has to pay for the hire of the meters on the stand pipes.

Mr. H. T. Wakelam: I should like to add my meed of praise to the Author for presenting such a valuable paper. I have watched this district growing under Mr. James's administration and care for some years past, and it affords me great pleasure to congratulate the Council on having so efficient an officer as Mr. James.

Mr. C. G. Lawson: I should like to ask the cost per annum of the electric lighting and the number of hours during which the lamps are burning.

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Mr. P. T. Harrison: I do not think it necessary to touch upon any point except that of the stables. As I am rather interested in that question at the moment, if Mr. James could let me know either the cost per horse, or the cost of the stables separate from the depôt building, I should appreciate it.

The President: Before putting this vote of thanks to Mr. James, with which I very heartily agree, I wish to refer to one or two points in the paper. I should like to echo the remarks of Mr. Capon as to the cheapness with which the tarring of the roads has been done. It seems an extraordinary price, less than ½*d.* a square yard. I should like to ask how many super yards are covered per gallon of tar. The addition to the paper of the average rainfall of the district would be useful information. I have used concrete kerbs, and find them fairly satisfactory. They do in time slip, but they are very true in line, and economical. We are using them on more or less country roads. Another paragraph in the paper in which I am very much interested is the standardisation of material. That is one of the most crying needs of the day, particularly with regard to road material. You have all kinds and sorts of stone labelled as granite. To a young official who is not conversant with the different quarries, it must be very difficult to advise his Council, when they are all marked with one brush as granite. There is a committee pushing forward standardisation, and I believe its efforts will help in the standardisation of our materials and bringing them into line.

Mr. Arthur C. James, in reply, said: I am exceedingly obliged to you for this vote of thanks. I am sorry there is not anything more to see in Grays than there is. We are very poor; everything has to be done economically, and there is not much to be seen on the surface. We try to do the work so that it has not to be done again. As to the surface-water drainage and floods, the flooding is due to the rainfall, not to the breaking of the river wall. We had one case of the breaking of the river wall, when we had to shut down the pumping at the sewage works altogether. The other times we have had flooding it has been merely a heavy storm. In June we had 1½ inch of rain in an hour. That flooded very considerably in this district, particularly in the low-lying part of the town. There is a chapel, with a school underneath, which had 3 feet of water in it. But that does not often happen. With regard to the

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collection of house refuse, at present we use carts. If we had to scrap these we should go in for vans, but I do not think I should go in for vans as large as 6 yards. As to roads, we have received 1500*l.* a year from the County Council. The reason for the lower cost of the main roads is entirely that which I have given in my paper. We have widened the roads, and taken the opportunity of putting in a good foundation of flint underneath, and put a good coat of metal on the surface. The tarring of the roads has also a considerable effect in increasing their life. The tarring has not been confined to main roads. The area of the roads is about double what it was about fifteen or sixteen years ago, and the cost is just about the same. We do not have much difficulty with trenches underneath the footpaths. We have bars from 6 feet to 10 feet long, with a special loose cast-steel head, which we drive under the paths, and thread either a cable or water or gas pipe through to the premises. We have only to break up a path if it is more than 8 feet wide, and then we cut open the path to a regular size, and keep slabs made ready for repair at once. We began our tarring very early this year. We began on April 2, and by the middle of May we had done it all. If you put off your tarring to June it does not save much in watering. We cover 7 square yards to the gallon, and with the dehydrated tar we cover 6 yards, at a cost of 0·55 of a penny. As to the refusal by the Local Government Board to grant a loan for the enclosed open-air swimming bath, the Board did not give reasons. It is probable it was thought to be too extravagant. The 4500*l.* was for the building and everything. We have not used tar macadam on private streets, but the last one or two streets we did tar-spray the macadam, before rolling, practically without any addition to the cost of water binding. It is too early to say whether it will stand. We shall pass the piece of street near the police station, which was treated in this way five years ago. It has to be tarred every year. There are one or two pieces of bituminous-grouted road. As to the smallness of the sewage flow, I may say the district is practically without any baths at all. In the mining districts in the north of England the flow is, I am told, practically the same as here. The sewers I believe to be absolutely watertight. After they were laid the sewers were lying empty for several months, and I was never able to trace any leakage into them, although they were, in parts, laid in low and marshy ground. The rainfall of

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the district is about nineteen inches per annum. I only know of Shoeburyness as being drier than we are. The water meters belong to the Council. We buy them and fix them. The Water Company used to charge us 27*s.* rent. The Water Company wanted about 70*l.* for them second-hand. Before we bought them we had paid 53*l.* in rent. I am much obliged to Mr. Wakelam for his kind remarks. I did not know that he had taken so great an interest in the district. Last winter we had Tantalum lamps in the street, the lanterns holding two 25-candle-power lamps. These we have converted into one Osram lamp, with the result that we are saving 150*l.* a year. I am afraid I cannot separate the cost of the stable from the other work in the depôt. The concrete kerbing was adopted sixteen years ago at the suggestion of the father of the present Chairman of the Council, Mr. Brooks, who had seen it in Philadelphia. It was tried against my wish, but I am convinced it is perfectly good—good enough for any purpose. I do not say it is good for heavy traffic, though I have seen it in Glasgow and Edinburgh; near to Princes Street, Edinburgh, and George Square, Glasgow, which are busy streets. I have seen a device for attaching a thin plate of iron, with ties, into the concrete. We have had it down for sixteen years, and it is most unusual to see even the mark of a cart wheel.

The Members drove to the Beach recreation ground, and open-air swimming and the new infant school and schools' bath at Bridge Road, which were inspected. The next visit was to the Wouldham cement works. On arrival here the Members were entertained to luncheon. After luncheon the Members inspected the works, following the processes of manufacture from the raw material right through to the finished product. The Members afterwards visited the works of Messrs. Siegwart, Limited, where they inspected the processes of manufacture and testing of reinforced concrete pipes.

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EAST MIDLAND DISTRICT. MEETING AT ILKESTON.

September 28, 1912.

Held at the Education Offices, Ilkeston.

R. J. THOMAS, M.INST.C.E., PRESIDENT, *in the Chair.*

THE members were received by the Mayor (Councillor S. Shaw, J.P.), who offered them a very cordial welcome to Ilkeston.

A hearty vote of thanks to the Mayor for his very kind welcome was proposed by the President, seconded by Mr. E. G. Mawbey, and carried unanimously.

The Executive Committee was then elected, consisting of Messrs. C. A. Clews, W. A. H. Court, T. W. Gordon, J. C. Haller, T. Henry, J. W. Horton, T. Lake, E. B. Purser, S. Turner, A. H. Walker, H. G. Whyatt and F. W. Wright.

WATER SUPPLY, ILKESTON.

BY HENRY J. KILFORD (*Member*),
BOROUGH SURVEYOR AND WATER ENGINEER.

ILKESTON is an old market town situate midway (about eight miles) between Nottingham and Derby. The population in 1831 was 4446; in 1881, 14,199; and in 1911, 31,673. The town in point of population was, until Chesterfield recently extended its boundaries, the second in the county of Derby. The charter for the market was granted to Hugh Fitz-Ralph by King Henry,

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1251. The chief industries are coal, iron, lace, and hosiery. The rateable value in 1884 was 44,728*l.* 5*s.* 6*d.*; in 1912, 88,329*l.* 10*s.*

WATER SUPPLY.

In 1884, when the writer commenced his duties, the water supply was a falling one, and was obtained from three sources, viz. (1) Queen Street; (2) Little Hallam; and (3) Heanor Road.

(1) The Queen Street pumping-station, situate in the centre of the town, was established by the late Ilkeston Waterworks Company, Ltd., in 1855. The pump-well was 46 yards deep, the yield originally 10,000 gallons of water per day. In 1884, the horizontal H.P. engine and pumps were capable of delivering in 1½ hours all the water the well could yield in 24 hours. This plant was set down in 1886, and removed later, but buildings are still in existence and are used as stores. The water was pumped into an open storage reservoir, with a capacity of 76,000 gallons, at the rear of the Town Hall.

(2) The Little Hallam pumping-station is situate inside and near the south-west boundary of the borough. In 1871–72 the Waterworks Company extended their works by forming two open storage reservoirs, about two and a half acres, with a storage capacity of about two and a half million gallons. The water for the supply of these reservoirs was derived from three sources, viz. the Oakwell spring, the Stanley Brook, and the Nutbrook. These brooks drain a watershed of about seven thousand acres; both brook sources were decidedly objectionable and polluted with sewage. The plant consisted of a non-condensing high-pressure beam engine, 18-inch cylinder by 2½-foot stroke connected to an 8-inch double-acting pump. Water was delivered to the above-mentioned reservoir at the rear of the Town Hall through 1 mile of 7-inch mains. Steam was raised in a Lancashire boiler 18 feet by 6 feet diameter.

These pumping plants (1) and (2), with engineman's cottage, land and water-mains, were purchased from the Waterworks Company by the Local Board in 1878. The Local Board immediately added two sand filters, having a sand surface of 526 square yards.

(3) The Heanor Road pumping-station is situate at the north end of the borough, and was established by the Local

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Board in 1878–9. The works adjoined a colliery, and comprised a shaft sunk about eighty yards deep into the coal measures, a water lodge in the coal seam, deep-well pumps, high-pressure non-condensing horizontal pumping-engine, one 30-foot by 8-foot Lancashire boiler, engine-house, and cottage. The yield of the well was about eighty thousand gallons per day. A covered storage reservoir with a capacity for 250,000 gallons was erected at the same time, at Shipley, just outside the borough, at an elevation of 382 feet (top water level) above O.D., giving a head of 50 feet in the market place. At a later date two sand filters were added. The plant was a modern one, but the quantity and quality of the water left much to be desired. This plant was abandoned in 1891; the water supply failed owing to colliery workings at a lower level.

In October, 1884, the Shipley reservoir was in a leaky condition, on account of mining operations, and the reservoir at Little Hallam empty. Steps were hurriedly taken to augment the supply, and within a week from the Author's report to the Board a disused colliery noted for its water supply, quantity and quality (?), situate just outside the borough at Kirk Hallam, near the Little Hallam pumping-station, was leased from Colonel Newdigate, the owner of the freehold, and the old plant, consisting of an 18-inch single-cylinder winding engine, a small horizontal pumping engine connected to deep well pumps by rods and quadrants, three old egg-end boilers, buildings, and sundry other apparatus appertaining to a colliery, were purchased. These were all in a deplorable state, having been set down several years, but in spite of it all, and the innumerable and almost insurmountable difficulties, water was being wound in barrels from the shaft and delivered through a new 6-inch main into the filters at Little Hallam in the time mentioned, and proved a great boon to the town for many years. The lease was for forty years and the rent 50*l.* per annum; this includes a house which is let at 20*l.* The yield of this source of supply was well maintained at 240,000 to 280,000 gallons per day. Gradually the old colliery plant was either put in good condition or scrapped.

Subsequently a Davy pumping engine, 45-inch steam cylinder by 8-feet stroke, was erected over No. 1 shaft and a new 18-inch bucket and plunger pump, 86 yards deep, fixed in the shaft, the pump rods being connected direct on to the piston

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rod. This pump would deal with the water in eight hours and deliver it through a 12-inch main into the filters at Little Hallam. A steam capstan engine was fixed near the No. 1 shaft capable of lifting 20 tons. The double set of pumps left in the No. 2 shaft used by the colliery company were of the ordinary deep-well old-fashioned bucket type delivering into a "launder" about 3 yards below the surface, these were altered so as to lift the water into the Little Hallam filters. Two 30-feet Lancashire boilers provided steam for all purposes. The new buildings for Davy engine, capstan, and boilers were of a substantial character. The whole was abandoned in 1904 (when the Meerbrook Sough scheme came into operation) and the pumps subsequently removed from the shafts under great difficulties, but with success. It is not often experienced that an engineer has the removal of plant of this nature he designed and put down. The Author could write a book upon the troubles and worries consequent on converting a disused colliery plant into a town's water-supply plant.

At Little Hallam a new engine house was built and a Worthington compound duplex jet condensing pumping engine by James Simpson erected therein capable of lifting 30,000 gallons of water per hour against a head of 300 feet. The water was pumped direct into a 12-inch supply main which was laid in from Little Hallam, through the town, to Heanor Road; the surplus or unconsumed water being delivered into the Shipley reservoir, from which the town was supplied by gravitation when pumps were standing. This arrangement of pumping was a great success, providing an adequate supply at a pressure of 100 feet in the Market Place, the highest point in the borough, 332 feet above O.D. This pressure could be increased when required for fire brigade purposes. The engine was under perfect automatic control and never at any time gave trouble under the varying conditions.

Later, another temporary engine house and pump well was built, and another Worthington compound duplex surface condensing pumping engine installed, capable of delivering 60,000 gallons per hour against a head of 300 feet through the same main. The quality of the water was not all that could be desired. Typhoid fever was prevalent, and this was traced to the water from the Nutbrook and Stanley Brook. The sand filters did not purify the water sufficiently, and the quantity

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required could not be passed through them, consequently two Reeves patent pressure filters were put down. The water was forced by the pumps through these with excellent results and the complete stamping out of typhoid.

"University of Birmingham,
"November 9, 1900.

"*Ilkeston Water.*

"DEAR SIR,

"I have now completed my examination of this water. It has taken longer than usual, on account of the difficulty experienced in correctly identifying one of the organisms isolated from the water. It presented many of the characters of the Bacillus Sporogenes Enteritides (the cause of certain diarrhœa epidemics); and it was only after a continued and prolonged examination that we were able ultimately to decide that it was not this germ. We had less difficulty in the case of the typhoid bacillus and the bacillus coli. They are not present in the water. There is no indication whatever of any contamination with human excremental matter.

"The estimation of the total number of germs present in the water is surprisingly low, considering the possibilities of pollution in the area from which the water is drawn. It gives 150 germs in 1 c.c., which speaks well for the efficiency of the filtration. This is the average of three separate and careful examinations.

"Yours truly,
"R. F. C. LEITH,
"Professor.

"H. J. Kilford, Esq.,
"Borough Surveyor,
"Ilkeston."

The serious pollution of the brooks, the increasing population and consequent demand for water, compelled the Committee to look round for another source of supply. The Author explored the district for miles, and later, in 1891–2, in conjunction with Mr. I. Hodges, mining engineer, prepared an exhaustive report upon the water in the district. There were many places where the quantity required might have been obtained, but liable to be lost at any time, and to contamination by mining operations. This

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area was subsequently examined and reported upon by Mr. Hodson and Dr. Barwise with same result, that all the waters were unsatisfactory, and could not be relied upon for a public water supply.

Boring for Water.

In 1893–5 the writer with Mr. Ashworth, mining engineer, and Mr. Fletcher, F.R.G.S., examined the district for many miles on the west side of the borough with the ultimate result of recommending the putting down of a borehole at Little Hallam. The boring was commenced February, 1896. The first portion was "jumped," and the lower portions cut through with the "diamond drill." Specimens of the cores may be seen in a case at the Free Library. Some of these cores in the grit came out 6 feet long. Water was struck at 837 feet, and rose in a tube 14 feet above the surface. The quantity overflowing at the surface was 180 gallons per hour. The boring was continued down to 1802 feet, but as far as could be ascertained no additional supply was struck. A shaft well was sunk and bricked to a depth of 125 yards. During the sinking the borehole tubes were removed, and at a depth of 53 yards salt water was met with; upon replacing the tubes the water issued at a higher level free from salt, perfectly bright, clear, and palatable. The source of the salt water was not ascertained. It is a coincidence that it was found practically at sea level. The maximum yield of the borehole and shaft was 300,000 gallons per day. The Town Council called in Mr. Hodson of Loughborough, and upon his advice the boring was abandoned. The cost of the boring was 1615*l.*; the first 50 yards 25*s.* 9*d.*, increasing 5*s.* per yard each 50 yards in depth; the last 50 yards, 87*s.* per yard.

The sinking of the shaft by direct labour to 125 yards proved a difficult undertaking, the strata passed through was full of water, which was pumped by two of "Evans" sinking pumps with sliding suctions; these were hung in slings, and lowered as the work proceeded. Trouble was experienced with clacks, valves, and their seatings, until the writer altered the method of securing them, after which the trouble ceased. The temperature (120 degrees) caused by two steam and two exhaust pipes (although these were covered with felt) was very oppressive and trying, and it was a relief to drop into the cold water in the shaft bottom. One fitter sent down to do some repairs refused to

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work under 5*l.* per hour. The shaft was 10 feet in diameter, brick-lined in cement mortar with oak curbs. It would have been much more convenient if this had been 12 feet, and the shaft sunk clear of the bore-hole.

The cost of pumping at Little Hallam, including coal, oil, filtering labour, gas, rents, rates, etc., was 2¾*d.* per 1000 gallons (against a head of 350 feet). The cost of distribution, including repairs and renewals, services and inspectors, ¾*d.* per 1000 gallons, making the total cost 3½*d.* per 1000 gallons. There are 27 miles of water mains within the borough, ranging from 3 inches to 12 inches. Some of the mains are much corroded, and will require new ones of greater diameter at an early date. Valves are placed so as to control each street and branch, and spindle hydrants about eighty yards apart, so that ample provision is made for the fire brigade. Trouble has been caused by excessive quantities of lime passing from the works into the reservoirs and pipes, Ilkeston suffering most in this respect. It is not so marked now; still, a small quantity is found in the reservoir at Shipley, hydrants in the town, and pipes of consumers. This lime deposit has, in some instances, completely choked up the iron hot-water pipes in houses; but it has no effect upon lead pipes used for this purpose.

Meerbrook Sough.

In 1890 the Author, and again in 1894, with Mr. John Holbrook, Surveyor of Heanor, visited the Wirksworth district and made exhaustive inquiries as to the source of the water issuing from the Meerbrook Sough, and the possibility of pollution and contamination from the Wirksworth sewage and lead mines. Gaugings of the water were made at the mouth of the sough, and the quantity was found to be about sixteen million gallons per day. A report was submitted to the Council, with sketch plans of proposed route, site for reservoirs, etc., and the cost of the scheme was estimated at 86,000*l.* The estimate of the cost practically held up the scheme for a long time until Mr. Hodson was consulted, when he strongly recommended the Meerbrook scheme, with the result that the Ilkeston and Heanor Water Board was formed, and an Act of Parliament obtained in 1901. The works, as now completed, comprise the pumping-station at Whatstandwell, a little north of the sough mouth.

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Here a noble building has been erected to contain the three compound condensing pumping engines (each capable of lifting 50,000 gallons per hour against a head of 500 feet through $2\frac{1}{4}$ miles of 18-inch pipes into the covered storage reservoir at Chadwick Nick), three 30-feet by 8-feet steel Lancashire boilers, Green's economisers, coal stores, fitters' shop, turbine-house, centrifugal and electric light plant-room, etc. The softening plant—Archbutt-Daley process by Mather and Platt—is under a separate roof; two dwelling-houses, gardens, railway sidings, and spent lime, storage beds, etc. The water from the sough is diverted through a turbine, which raises part of the water required; the remainder is pumped up by centrifugal pumps into a large iron tank forming the roof of part of the buildings, from which it passes on to the softening plant. The water is here reduced from 22 to 8 degrees of hardness; thence it passes into the pure-water tanks under the softeners, from which the pumps take their supply.

The works are beautifully situated by the side of the River Derwent, close to the main road from Derby to Matlock, and are well worth a visit by any who may be interested in the lifting, and treatment by softening, of water for a town's supply.

The storage reservoir at Chadwick Nick has a capacity of 1,400,000 gallons and is at an elevation of 700 feet (top of water) above O.D. The water gravitates through 16, 15, and 14-inch pipes to Codnor Park and Tag Hill reservoirs for Heanor and to the Shipley reservoir for Ilkeston. The water is supplied by meter into the several reservoirs and the cost of the works to this point is borne by each constituent authority according to the quantity taken.

Difficulties have been experienced by leakage from the mains. The following figures are taken from the engineer's reports:—

Sept., 1906	.. .. ..	1,870,000 gallons
Oct. „	.. .. ..	3,370,000 „
Nov. „	.. .. ..	6,141,000 „
Dec. „	.. .. ..	13,098,000 „
Jan., 1907	.. .. ..	33,775,000 „

In February, 1907, the writer examined and tested the mains for the Board, and found that the bulk of the leakage was from the $2\frac{1}{4}$ miles 18-inch pumping main. This was a terrible loss, necessitating practically day and night pumping.

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The joints of the pipes were found defective; these have been made good, and the leakage is now practically *nil* between the pumps and Chadwick Nick reservoir. The leakage upon the whole of the mains has been reduced to about 25,000 gallons per day.

The undertaking involved a capital expenditure of 120,000*l*. The cost of the water to the two authorities is about 6*d*. per 1000 gallons.

The Ilkeston storage reservoir at Shipley is built upon land under which coal has recently been worked. Upon examination this month it was found that fractures had occurred in many places in the floor, walls, and vaulting. Upon testing for leakage it was found to be practically water-tight, thanks to clay puddle. The ascertained leakage being equal to a drop in surface level of 0·08 (340 gallons) in twenty-four hours, another test was interesting, as rain was falling the whole time and the surface of the water rose slightly, the rain must have percolated through the roof cracks. Care was taken that no water was leaking in through the valves.

The water pressure in the highest part of the borough (the Market Place, 332 feet above O.D.) is inadequate, and must be increased. The Author has designed a water tower with small tank, at an increased elevation of 50 feet above the water level in the storage reservoir, in which to place valves, etc., and to break the Chadwick Nick pressure, and to give a head of 80 feet in the Market Place. Experiments are being made, but not quite completed, to pass the water through a pressure-reducing valve; if successful the tower will not be built; but the Author is certainly of opinion that the tower, though more costly, would, in the end, be the most satisfactory.

The Author is considering the question of utilising the waste or lost pressure and energy, the drop between Chadwick Nick pressure and the reservoir (which is equal to 700,000 gallons of water falling 240 feet every twenty-four hours), for generating electricity; the problem is a difficult one, as the conditions are peculiar, and the consumption of the water varies from 10,000 gallons per hour to 50,000; it is also imperative that the pressure on the outlet or exhaust side of the turbine, or other hydraulic engine, be maintained constantly, at about seventy feet. The quantity of water supplied daily is 700,000 gallons, equal to 22 gallons per head for all purposes. Deducting the

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ILKESTON AND HEANOR WATER SUPPLY.

Collected January 10th, 1910. Examination started same day.

Description of Sample.	Number of Microbes per c.c.			B. COLI TEST.																		B. Enteritidis Spor. Test.		
				Presumptive.						Confirmatory.						Typical.								
Meerbrook Sough...	Gelatin at 21°C. after 48 hours.	Agar at 37°C. after 48 hours.	"Rebipelagar" at 37°C. after 48 hours.	Gaseous Fermentation of Bile Salt Broth, Gas and Fluorescence in Glucose Neutral Red Broth.						Isolation of a Coli-like Microbe on Neutral Red Bile Salt Agar.						Coli-like Microbe giving the following Reactions:— Fluorescence in Gl. N. R. Broth. Acid and Clot in Litmus Milk. Indol in Peptone Water. Acid and Gas in Lactose Litmus Broth.								
				Bile Salt Broth.		Glucose Neutral Red Broth.				Bile Salt Broth.		Glucose Neutral Red Broth.				Bile Salt Broth.		Glucose Neutral Red Broth.						
				10c.c.	1 c.c.	30c.c.	10c.c.	1 c.c.	·1 c.c.	10c.c.	1 c.c.	30c.c.	10c.c.	1 c.c.	·1 c.c.	10c.c.	1 c.c.	30c.c.	10c.c.	1 c.c.	·1 c.c.	10c.c.	5 c.c.	1 c.c
Untreated	13	4	One Colony of a small spindle-shaped Bacillus.	+	+	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Treated	0	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

+ Means reaction given. — Means reaction not given.

water passed through the meters, it gives a net consumption for domestic purposes only of 16·5 per head. There are ninety-four meters of different makes in use, with a daily consumption varying from 50,000 downwards. The average daily consumpion by meter equals 5½ gallons per head of the population. The water is of excellent quality. Dr. Barwise has frequently analysed it, and one of his reports reads as follows:—

"*Ilkeston and Heanor Water Supply.*

"On January 10, this year, I collected a sample of the Meerbrook Sough water before and after softening, and have submitted the same to a complete bacteriological examination. Your Committee will remember that at the time of the promotion of the Ilkeston and Heanor Water Bill it was suggested that sewage from Wirksworth occasionally found its way into this water after heavy rains. I selected January 10 because there had recently been a thaw, and the Sough water had not the brilliant transparency which it usually has. The bacteriological results of the water before treatment confirmed the results previously obtained, and indicate that it is a pure supply. The water after treatment is exceptional, and I doubt whether there is another supply in the country of equal volume of the same purity.

"The results show that there is not a single organism of either suspicious or innocent nature growing therein. The attention of the Heanor District Council and the Corporation of Ilkeston should be called to these results, and it might be pointed out that they have an opportunity of starting a fresh industry, as the supply is admirably suited for the manufacture of high-class *Aerated Waters.*

"SIDNEY BARWISE."

The total indebtedness upon the water undertaking is 56,411*l.* 3*s.* 8*d.* The income last year was 7693*l.*, the outgoings 8153*l.*, showing a loss of 460*l.*, which is equal to a 1½*d.* rate.

The writer apologises for the crudeness of his paper; his intention was, when commencing to write, to embrace and describe briefly, with cost, etc., the whole of the works appertaining to his many departments; but, owing to lack of time and unforeseen circumstances, has been compelled to alter the heading and to confine his remarks to the water department only.

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ILKESTON SEWAGE DISPOSAL WORKS.

By HUGH P. RAIKES, M.Inst.C.E.

The question of sewage disposal has for many years occupied the attention of the Ilkeston Local Board and Corporation, the waste water and sewage being discharged by means of ditches, pipes, and stone drains into the Erewash Canal and the River Erewash up to 1883, when the population of the town was about 15,000. In order to prevent the pollution of the canal and river the Ilkeston Local Board in January, 1883, adopted a scheme of sewerage and sewage disposal, prepared by Messrs. Brundell and Simonds, of Doncaster, comprising a main intercepting sewer about three miles in length, from Bridge Street, Cotmanhay, to the Outfall Works at Hallam Fields, this sewer being completed in January, 1884. In order to purify the sewage, the Local Board also acquired about 41½ acres of land situated on the western bank of the River Erewash, between Gallows Inn and Hallam Fields, 5½ acres being used for intermittent downward filtration and 36 acres for broad irrigation. The town was incorporated in 1887, and continued to grow very rapidly, large numbers of houses being built on land below the level of the main intercepting sewer.

In 1896 low level sewers were laid by Mr. Kilford, the borough surveyor, from Awsworth Road to Potters Lock, and from Nottingham Road to Gallows Inn ; but as the sewage from the latter could not be discharged on to the existing farm at Hallam Fields, three upward flow Ives' tanks were constructed at Bridge Street, Potters Lock, and Gallows Inn for precipitating the sewage, small areas of land at Potters Lock and Bridge Street being taken on lease from the Duke of Rutland, and about 15 acres were also purchased at Gallows Inn as sites for tanks and for treating the tank effluent by irrigation. Houses continued to be erected at Hallam Fields, adjoining the sewage farm, and owing to complaints from the inhabitants in this district, irrigation on the farm was abandoned in 1900 and the sewage of the

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town was discharged at the low level outfalls at Gallows Inn and Potters Lock where the Ives' tanks had been installed. This resulted in the tanks being considerably overworked, so that they produced an unsatisfactory effluent, which seriously contaminated the waters of the River Erewash.

The County Councils of Nottinghamshire and Derbyshire made strong complaints to the Corporation respecting this serious contamination of the river, and ultimately the Derbyshire County Council obtained an order from the Courts compelling the Ilkeston Corporation to take the necessary steps for dealing with the sewage of the town in an efficient manner, in order to prevent the pollution complained of. In these circumstances the Corporation decided to retain the services of Messrs. Willcox and Raikes, M.M.Inst.C.E., civil engineers, of Westminster and Birmingham, who, after carefully investigating several alternatives, advised the adoption of a new site for the sewage disposal works at the extreme south end of the borough. They further recommended the purification of the sewage by bacteria treatment, consisting in liquefying tanks and percolating filters, for which purpose only a comparatively small area of land was required for constructing the works necessary to meet the requirements of the Local Government Board in regard to the treatment of the sewage before discharging the effluent into the river. The recommendations of the engineers having been approved by the Corporation, it was finally decided to acquire a site about 1½ miles from the centre of the town, comprising an area of about 18 acres, adjoining the Midland Railway to the east of the Stanton Ironworks on the property of the Duke of Rutland. This site is well adapted for the purpose, as it is readily accessible from the town and well removed from any dwellings, besides being close to the river, into which the purified effluent must in any case be discharged, though special precautions have been necessary to prevent flooding. The site was purchased from the Duke of Rutland by agreement, and the engineers were then instructed to prepare a scheme for dealing with the whole of the sewage of the borough; the dry weather sewage flow of 25 gallons per head for a population of 30,000, being estimated at 750,000 gallons per day.

Complete plans and estimates were shortly afterwards submitted to the Local Government Board, together with an application for sanction to a loan of 32,600*l.*, to cover the cost of the scheme recommended by the engineers. The loan was duly

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sanctioned by the Local Government Board, and Messrs. Willcox and Raikes were then instructed to prepare the detailed specifications and the other particulars necessary for the purpose of obtaining tenders and carrying out the work. The tender of Messrs. George Bell and Sons, Limited, of Tottenham and Manchester, was accepted for the whole of the structural work, which was commenced in June, 1909, Mr. F. W. Wright being appointed to the position of resident engineer.

The sewage was already being conveyed through the old intercepting sewers to a point on the Hallam Fields Sewage Farm, north-west of the Erewash Canal, and from this point it is now taken for a distance of 526 yards, through two new 18-inch cast-iron pipes laid in the form of an inverted syphon, under the Erewash Canal and the Midland Railway to a point at the north end of the site of the outfall works. On reaching the outfall works, the sewage is first treated in settling tanks and afterwards on bacteria beds worked on the percolating system, provision being also made for passing the filtered effluent through a humus-tank before it is discharged into the river. The general arrangement of the works is shown by illustration No. 2, from which it will be seen that the tanks and engine-house are constructed at the north end of the site; the bacteria beds, which are rectangular, being immediately to the south of the tanks, and the humus-tank still further south. The whole site is surrounded by artificial banks formed out of the surplus excavated material, as a protection against flooding, the banks being planted with shrubs and enclosed by an iron fence all round. The tanks are four in number, each 120 feet by 31 feet inside, with an average depth of 8 feet and a total capacity of 750,000 gallons; but as it is desirable to completely empty the tanks as seldom as possible, a portion of each is cut off by a cross wall 15 feet from the inlet end, so that the heavier solids deposited in this portion can be removed without disturbing the rest of the sewage in the tank, the top of the cross wall being just below the water level, thus forming a weir, over which the sewage passes in a uniform stream when the tank is in use.

The rate at which the sewage reaches the tanks is regulated by means of a weir orifice fixed in the inlet chamber, and so designed that, when the rate of discharge exceeds three times the dry-weather flow, any excess will pass through the settling tank reserved for storm water, and thence direct to the river.

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Provision is also made for measuring the sewage which passes to the bacteria beds by means of Messrs. Glenfield & Kennedy's automatic recording instrument.

For the purpose of emptying the tanks, special decanting valves are provided, by which the supernatant water can be drawn off as required and pumped back into one of the other tanks, the sludge being pumped into lagoons, which are described later. The tanks are constructed of cement concrete faced with brickwork on the outside and finished with granolithic coping, the whole of which has been made on the works by the contractors. The floors are also formed with granolithic paving on a concrete foundation, with a shallow channel down the centre of each tank to facilitate the removal of sludge. The effluent from the tanks flows over a weir, and is received in an effluent channel, from which it passes through two 15-inch cast-iron pipes to the bottom of two sedimentation tanks constructed somewhat on the lines of a Dortmund tank, each 12 feet square and 15 feet deep, the bottom of each tank being formed in the shape of a cone. The effluent from these tanks flows over a weir and passes into a channel containing rough graded granite, to act as a strainer, by which any suspended matter may be removed before it is discharged on to the bacteria beds. The two bacteria beds are rectangular in shape, each 226 feet long by 200 feet wide and 5 feet deep, with a total area of 10,000 square yards, each being divided into four sections for convenience of working. The outer walls are constructed of cement concrete with a brick facing, the concrete floor being finished with granolithic paving in which there are half-pipe effluent channels covered with slotted tiles, the floor and the channels having a 6-inch fall from the centre of the beds to the outside. For the purpose of discharging the sewage on to the rectangular bacteria beds, a special type of distributor was designed by the engineers for use at Hanley, where they have proved very successful, and a similar system has therefore been adopted in this case, so a short description of their construction may be of interest.

The sewage distributors have been manufactured by Messrs. Hartley & Co., engineers, Stoke-upon-Trent, and are shown in illustration No. 5, being arranged to discharge over half-acre units, each 226 feet long by 100 feet wide. An open steel trough, 1 foot 10 inches wide and 1 foot 11 inches deep, is

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provided between each half-acre unit, and the troughs are fixed perfectly level, the bottom being 6 inches above the surface of filtering material, and they are carried on two rows of 6-inch by 6-inch reinforced concrete pillars fixed in the floor of the bed. The sewage is drawn from each trough and discharged into the perforated distributing arms by means of travelling syphons, each distributor forming one complete arm extending on either side of the trough. The arms travel backwards and forwards the whole length of the bed, meeting and passing each other when at the middle of each journey, the motive power being provided by electric motors and wire ropes. The distribution of sewage takes place when travelling in one direction only, thus giving a uniform interval of rest between each dose of sewage as well as a uniform rate of discharge.

The construction of distributing pipe is shown in the illustration No. 5, the sewage passing into the nozzles from the main pipe at the top, so that this pipe is never emptied, and the discharge of the sewage therefore commences and stops along the whole length of the pipe almost instantaneously, and any deposit in the bottom of the main pipe cannot obstruct the outlets to the nozzles. The top of each nozzle pipe is closed by a plug, and when this is withdrawn the apertures can be easily cleaned, while a baffle plate beneath each nozzle sprays the sewage and distributes it over the filtering medium, so that when the nozzles are discharging there is a continuous film of sewage falling on the whole width of the bed. Between the syphon and the main distributing pipe is a valve operated by levers, so that the distribution of sewage is automatically stopped or started when one of these levers encounters a stop fixed in the end of the trough. As both main pipes distribute on one journey and are idle on the succeeding journey, it is possible to greatly vary the amount of sewage distributed by increasing the time of the flow journey and decreasing the time of the idle journey, and the periods of rest can also be adjusted and controlled until the best results are obtained.

The main distributing pipes are drawn along the rails by wire ropes; and as they would require considerably more power during high winds if independently driven, they are connected together by a balancing rope, which passes round grooved pulleys at each end of the bed. When wind adversely presses against one distributor, its effect is largely counterbalanced by

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the wind pressure against the distributor on the opposite side of the trough, so that a very small electric motor is sufficient for the work, only 1½ horse-power being required to drive each half-acre distributor. The ends of the wire ropes are secured to and bound upon a revolving drum, so that one end of the rope winds up as the other unwinds, and when the arms reach the end of the bacteria bed the direction of the revolution of the drum is automatically reversed, the distributors then proceeding upon the succeeding journey, and on its completion the motion of the drum is again reversed. The reversal of the winding drum at the end of each journey is accomplished by a screw which revolves with the drum, there being a nut on the screw which travels along its axis until the required number of revolutions have been made, when the nut encounters a pedant lever and throws over the belt-striking gear, thus reversing the motion of the drum and arms. The nut then travels in the opposite direction until the end of the succeeding journey, when it engages in a second pedant lever, so that the motion is again reversed.

The distributors have been designed so that they can uniformly distribute a dose of sewage of from one to two gallons per yard over the area they cover at intervals varying from five to ten minutes as desired, and each ½ acre distributor on working twenty-four hours consecutively is capable of discharging 500,000 gallons during that period. The whole of the rails on which the distributors run are supported by 6-inch by 6-inch reinforced concrete piers built into the floor of the beds and finished by means of a cast-iron cap with bolt holes, to which the rails are attached.

The electric current driving the distributors is taken from the corporation tramway system (voltage 500 D.C.), the cables being brought underground from the tramway terminus at Hallam Fields to the sewage works for a distance of about half a mile. The motors are 3 B.H.P., and are capable of being used on any voltage from 450 to 550, being provided with resistance strips across the ends of the series winding, which can be altered on the site to suit the actual line voltage. When the ordinary power mains of the corporation are extended as far as Hallam Fields the electric current will be taken from these instead of the tramway, and the motors will then be altered to work with the 460 volt current. The whole of the motors used in

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connection with the sewage disposal works are identical in design and interchangeable, so that repairs can be made without involving the stoppage of the plant for any length of time. By means of straight and crossed belts from the motor pulley, with two loose and one fast pulley on the reduction train, the motor running in one direction only is enabled to drive the drums carrying the haulage ropes of the distributor alternately first in one direction and then in the other, so that the distributor travels backwards and forwards over the bacteria bed without requiring any manual control in the manner already described.

The most interesting part of the electrical equipment is the automatic control gear, and this is believed to be the first occasion where the whole of the work of controlling sewage distributors is done automatically by the introduction of electricity. At the outlet end of the liquefying tanks there are two chambers, from which the tank effluent is conveyed direct to the distributor troughs by means of 15-inch cast-iron pipes; and in each of these chambers there is a special float switch, which controls the supply of tank effluent to the troughs. When the water in the chamber rises 3 inches above a certain level the float is lifted, at the same time pushing up a brass rod, which engages and throws in a quick break-knife switch. At each succeeding 3-inch rise in the water level the same operation is repeated, and as the water level in the chamber falls the reverse action takes place. The two switch-boxes are interconnected, so that when the pair of beds connected with either switch is not in use the other switch-box will still be in operation; and should any defect occur in one the other will continue to operate the motors. From these boxes pilot wires are run on to the main switch-board in the first motor house, on which there is a selector switch so designed that, by turning a brass pointer travelling over a numeral plate attached to the front of the switch, the number of the distributor to which the pointer is set will first come into operation. As the float continues to rise the distributors will come into use automatically in correct sequence, and as the water falls they will also automatically fall out of operation. The distributors themselves are numbered 1, 2, 3, and 4, and if it is assumed that No. 3 distributor is the one which is first required to come into operation, then the order of starting up would be 3, 4, 1, 2, and they would fall out in the sequence 2, 1, 4, 3; but no matter which motor

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is started first the sequence is always the same, so the attendant only has to set the selector switch to the number of the distributor which he requires to be first operated.

The method of starting up the motors is as follows:—The current passes from the main supply through the float-switch, then through the selector switch to a magnetic coil on the motor starter. As soon as this coil is magnetised it pulls up the arm of the switch, gradually starting the motor until it is up to full speed, when the main switch is closed and the motor continues running until the float-switch goes off; the magnetic circuit is then broken, allowing the starting switch of the motor to fall down, thus stopping the motor. In order to ensure that the distributor will always stop on the non-distributing journey, an auxiliary switch has been provided on the "throw-over lever," which is brought into operation by the belt striking gear, so that the motor is always kept running when the distributor is actually distributing sewage on the beds. Each motor house is provided with its own starting gear and distributing panels, but none of this gear will be operated by hand except in case of repairs, when, by pulling out the switch controlling any particular bed, the corresponding motor is put out of operation. Pilot lights have been fixed on the top of each motor house (one for each motor), so that the man in charge of the works at night can always see from any point which beds are at work and which standing.

In order that each bed may do approximately the same amount of work, an automatic electrical recorder is also provided in connection with the float gear to show the number of hours that each motor is actually working. The charts from this instrument will enable the manager to work the beds uniformly and give each its required period of rest, as he can readily ascertain the quantity of sewage treated on each section. The electric motors, pumps, and switch-boards have been supplied by the Rees Roturbo Manufacturing Co., while the automatic gear has been supplied by the Adams Manufacturing Company to the specification of the borough electrical engineer, Mr. H. P. Stokes, in order to meet the special requirements of Messrs. Willcox and Raikes' scheme. The winding gear, motors, and switch-boards previously described are erected in two motor houses (two sets of machinery in each), which are built on arches carried between the two bacteria beds, as shown in the illustration No. 8. These motor houses are

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17 feet by 15 feet inside and 10 feet from floor to roof, the walls being constructed of brickwork with York stone plinth, cornice, and coping. Inside, the walls are finished to a height of 6 feet with brown glazed brickwork, and above this they are plastered and distempered. The roof is composed of cement concrete carried on joists and finished with a $\frac{3}{4}$-inch coat of asphalte, the floor of the house being finished with red tiles, and the gangways round the house are paved with 2-inch granolithic paving.

The efficiency of a percolating filter not only depends on the uniform distribution of the sewage over the surface of the bed, but also on the selection and grading of a suitable filtering material. Very exhaustive enquiries were therefore made in the surrounding district to determine the most suitable materials available for filling the beds, an experimental filter being also put down on the old sewage farm and worked for approximately twelve months for the purpose of comparing the results obtained with granite, clinker, saggars, and slag or furnace cinder. It was found to be practically impossible to obtain the whole of the 16,000 cube yards of material required from any one source within a reasonable time, so it was finally decided to have one acre of granite, one half acre of clinker, and one half acre of slag. The granite was supplied by the Croft Granite Co., the clinker by Mr. Frank Keep, and the slag by the Stanton Iron-works Co., the sizes of the material varying from $2\frac{1}{2}$ inches to $\frac{1}{4}$ inch, the smaller size being placed at the top of the filters and the larger at the bottom. The whole of the filtering material has been most carefully crushed and screened by specially constructed machinery in order to remove dust and secure uniformity of size, in accordance with the specification. The sewage, after being distributed by the nozzles of the distributors over the surface of the beds, percolates through the filtering material to the underdrains and from these into the main effluent channels, which discharge into the circular humus tank. This tank is 21 feet diameter and 28 feet deep, of the Dortmund type, with a cone-shaped bottom; the cone is constructed of concrete reinforced with $\frac{1}{2}$-inch indented steel bars, and the walls are built in brickwork finished with York stone coping carried about 3 feet 6 inches above ground level.

The filtered effluent is delivered into this tank by means of an 18-inch steel tube, which is carried down vertically to within 8 feet of the bottom of the cone; the final effluent then rises

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upwards, and passes out of the tank over a series of weirs into the main outlet chamber, from which it flows direct to the River Erewash. A house is built over this tank, similar in construction to the motor houses, in which a vertical spindle Rees Parker enclosed motor is erected, developing 4 B.H.P. at 1000 revolutions per minute on 500 volt continuous current. This motor is directly coupled by means of a vertical shaft, 10 feet long, to a Rees Roturbo self-regulating centrifugal pump for emptying the tank or removing the deposit therefrom, and capable of delivering 10,000 gallons per hour against a total head of 33 feet, this pump being fixed on girders built into the walls of the tank with the suction pipe carried to the bottom of the cone.

The sludge from all the tanks is delivered to a pump well, which is constructed underneath the engine house shown in the illustration No. 10; this pump well is 29 feet long by 14 feet wide, and about fourteen feet deep, built on a concrete foundation, with the walls constructed of brickwork in cement backed with clay puddle. The well is divided into two by a brick wall, the compartments being connected at the bottom by a 12-inch pipe and penstock valve. Built over this pump well on concrete jack arches and steel joists are the engine house and store room; the former is 20 feet by 14 feet, and 8 feet 6 inches to the underside of the roof, and similar in construction to the motor houses already described, except that it has a slate roof instead of concrete. In this engine house there is a double acting horizontal sludge pump, capable of delivering 16,000 gallons of sewage per hour, against a total head of 27 feet when running at a speed of twenty-three revolutions per minute. For driving this pump a 6½ B.H.P. Rees Parker enclosed motor is provided, similar in every respect to those previously described for driving the distributors.

The sludge from all parts of the works is delivered into one of the compartments of the pump well and pumped to the sludge lagoons, which consist of four beds, each 97 feet long by 47 feet broad, so constructed that the liquid matter drained out of the sludge is collected by the drains and discharged into the second compartment of the pump well, from which it can be pumped back into the tanks through a 5-inch rising main. The solid sludge will be left on the lagoons until it is sufficiently dry to be carted out on to the land at the south end of the works. The

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electric current for lighting is provided from the ordinary lighting mains and is connected up at the Hallam Fields terminus, overhead aluminium wires being taken to the works, where a disconnecting pillar is fixed for isolation and testing purposes. This pillar is fitted with a main switch, fuses and meter, and the current is distributed where required on the works by twin wires laid underground, insulated with paper and lead covered. Lighting standards and lanterns have been supplied by Messrs. Lucy and Co., of Oxford, and carry four 50-candle power metal filament lamps, and each of the outside fittings is controlled by separate double pole switches and fuses attached to the standard itself, which are operated by means of chains. A manager's house and workman's cottage are to be erected near the entrance to the works at the north-east corner of the site, where provision will be made for telephonic communication with the corporation's electricity station. A good supply of water is provided by a 1-inch service pipe connected with the town water main. The whole of the above works have been carried out and completed under the immediate supervision of Mr. F. W. Wright, without incurring any extra expenditure beyond the amount of the original contract, which was well within the engineers' estimate of 32,600*l.*, submitted to the Local Government Board in January, 1909. Practically all the work has been executed within the time specified, including the various subsidiary contracts for machinery, etc., as well as the main contract undertaken by Messrs. Bell and Sons.

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ILKESTON TRAMWAYS AND ELECTRICITY SUPPLY.

By HARRY P. STOKES, Engineer and Manager.

In dealing with the electricity supply and tramway system of the Ilkeston Corporation, you will of course understand that having only occupied the position of borough electrical engineer and tramways manager for a period of three years, certain information with respect to the concern has been obtained from more or less indirect sources. Early in March 1898 a company at Nottingham approached the Corporation with a scheme for putting into operation a system of cable cars, but the Corporation came to the conclusion that if a private company could see any good was likely to result from the operation of a system of cars in a town the size of Ilkeston, whatever benefits were to be obtained might as well be had by the municipality first hand. Steps were, therefore, taken to construct an electric tramway system, and a provisional order was obtained from the Board of Trade. Mr. V. B. D. Cooper of London was appointed consulting engineer, and submitted plans and estimates for the scheme, which were adopted by the Council. About the same time the Nottingham and Derbyshire Power Co. proposed to erect a number of generating stations for the supply of electricity in the counties of Nottinghamshire and Derbyshire, and as the price they offered to the Borough for the supply both for light and power purposes was considered a reasonable one, the Council abandoned their own scheme so far as generating electricity was concerned, and decided to purchase in bulk from the power company. The contract for laying the lines, erecting overhead equipment, and supplying cars, was let to Messrs. Dick, Kerr and Co., of Preston; and that for the car sheds and offices to Messrs. Moss and Sons, of Loughborough; and that for cables for electric supply to Messrs. Callender and Co. Considerable delays were experienced after the tramways were ready for

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operation in obtaining the necessary supply of electricity from the power company, and it was not until May 1, 1903, that the first car was able to commence running. The system was passed by the Board of Trade on Friday, May 15, 1903. The tramway track is 3 feet 6 inches gauge, and the district being a colliery one, considerable trouble has been experienced throughout its life with respect to maintenance.

There is no doubt that the original work was not as satisfactorily carried out as one could have expected, and unfortunately, what is known as "Dicker" rail joints were adopted, and these not having been well fitted in the first instance, continual trouble with rail joints has been the result. Extensive reconstruction of the bed has had to be carried out during recent years; in fact, practically the whole of the track has now been gone over. We are gradually introducing new rail joints throughout the system. These are known as the "Atlas" joints, and have a web on the fish plates which extends right under the bottom flange of the rail, the two fish plates meeting one another, and being secured, in addition to the ordinary fish-plate bolts, by means of two special truss bolts underneath the bottom flange. Only a few of these have been installed up to the present, but the work is being proceeded with as rapidly as possible, and their success is already well assured.

The overhead, when first erected, was of 0 trolley wire, with only single insulation; as a result, continual breakages were occurring, and some new wire was put up after only four years' operation. Unfortunately 00,000 and 0000 wires were used on separate occasions, thereby adding to the difficulties of maintenance. During the last three years the whole of the overhead has been reconstructed, double insulation having been provided, and 000 non-fouling wire fitted with mechanical ears. The car-sheds are situate in Park Road, and have a handsome frontage; the shed has accommodation for fifteen cars, but, unfortunately, was somewhat badly arranged for dealing with repairs, and no paint-shop has been provided. Additional machines and tools have recently been installed, and the whole of the repairs are now carried out on the premises. The depôt is now supplied with a large lathe for wheel-boring and turning and heavy work, another lathe for armature turning and binding, and a small lathe for the lighter class of work, a vertical drilling machine, Stirling hack-saw machine, emery grinder, wheel-press, forge,

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etc. Nine of the cars are Dick Kerr equipment throughout, the other four are Milnes Voss bodies fitted with Westinghouse equipment.

Whilst referring to cars, it may be of interest to note that we have had considerable trouble with rotten timber in the roofs, and are now adopting a new method of roof construction. Originally, the plank to which the trolley standard was bolted was simply screwed down to the ends of the cars, and the strain which occurs to the tops of the cars through the weight of the platform, caused the top deck roofing to buckle, and eventually let the water into the roof, with disastrous results. We are now using only solid oak planks, and these are armoured with 2-inch by ⅜-inch iron running the whole length, rabbeted and screwed into the plank; angle irons are run from the car body principals across the ends of the cars, and to these the trolley plank is bolted through the iron straps, the trolley standard itself being bolted through the plank and iron straps to the base plate below. A side fillet is run all the way round the car of solid oak 4½ inches by 2 inches, and a double floor is constructed of ⅞-inch red deal, 3 inches wide, with plain rabbet on either side, the second floor overlapping the seams of the first; the two floors are screwed together with a layer of lead between, to make the whole roof water-proof. Wrought-iron tread strips are being adopted in place of the wooden laths, and by this means we hope to prevent the damp getting into the timbers.

When the tramway system was put into operation, a universal penny fare was adopted, and a continual loss has always occurred on the working of the system, varying from 1800*l.* to 3200*l.* per annum; but in April last, after the conclusion of the coal strike, the Council approved of a new system of fares, comprising a three-halfpenny through fare, with penny intermediate stages, and this new system is already helping to bring about an increase in the receipts. The operating costs of the tramways in the first two years of working were nearly 8*d.* per car mile, and three years ago they amounted to 6·85*d.* per car mile; last year they were 6·02*d.* per car mile, notwithstanding the heavy renewals which have been carried out, and when it is taken into consideration that on a small system the size of Ilkeston there is a certain limit below which it is impossible to go with regard to staff, you will find that our operating costs compare very favourably with those systems of a similar size.

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In connection with the electricity supply, the system is known as the three-wire solid system, bitumen cables being laid in troughs, and filled in solid with bitumen. The supply is direct current 460 volt and 230 volt. Recently additional isolation boxes and feeder pillars have been introduced to facilitate dividing up the system into smaller sections for locating faults, and serious troubles have been avoided.

The distribution originally all took place from the car depôt, a pair of heavy feeders running from there to Station Road, and distributing solely from that point. We now have three separate feeders from the power company, and eight separate feeders of our own. The switch-board and balancers adjoin the tramway depôt in Park Road, but considerable alterations and improvements have been made within recent years and a sub-station equipped to deal with the load at the lower end of the town.

Our charges for electricity supply are among the lowest in the country, and the department two years ago made a profit for the first time, but this profit is an increasing one. Very little attention had been given to electricity supply for power purposes, in fact electrical driving had been discountenanced as much as possible, but we are now making good progress in this direction. In 1909 only fourteen horse-power in motors were connected to the mains; we now have just over one hundred horse-power connected. The electrical plant at the new sewage disposal works was installed by this department, and another interesting installation has just been completed in one of the lace factories where steam had to be competed with. The motor has been especially built for the work, also the automatic starting apparatus, and chain driving is used instead of belt. The result has been a complete victory for electricity, notwithstanding the intense prejudice which had to be overcome. The units purchased for lighting in 1909 were 283,000, and last year they were 352,000. The losses in distribution in 1909 were 16 per cent. and in 1912 3·9 per cent. Considerably more progress would have been made in this department but for the fact that our capital account was exhausted, and no new borrowing powers having been obtained, all new extensions to mains have had to be provided out of revenue, thus considerably handicapping the progress of this department.

The question as to the advisability of introducing a tramway system into a town the size of Ilkeston, is of course a question

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of the past, and the only thing to be done now is to obtain more patronage for the cars, and keep the working expenses down to a minimum, yet at the same time it is no use shirking the responsibility of maintaining the concern in a high state of efficiency. The amount of money spent on repairs and maintenance on the permanent way during the first seven years of working only worked out at about ½ per cent., whilst the overhead equipment (due to continually repairing a small section of wire) worked out at nearly 7½ per cent., and cars 10 per cent. per annum on the original costs. Had a larger sum been spent on the maintenance of the permanent way which is the most vital part of the system, there is no doubt that a great proportion of the heavy items of expenditure which have been incurred during recent years would have been eliminated. The car depôt and works are conveniently situated for any member desirous of inspecting same, and any point of interest will be thoroughly explained. In conclusion, the writer must apologise for the inefficiencies of the paper, but trusts that the visit to the town will be an interesting and helpful one.

DISCUSSION.

MR. E. G. MAWBEY: I should like to propose a hearty vote of thanks to the Authors of these three papers. I see, first of all, that the total flow is given by Mr. Raikes as 25 gallons per head per day. I should like to know why the total flow is given as only equal to 25 gallons per head. The sewers must be very tight. I should also like to know whether there is any separate system, and an idea as to the volume you expect to have to deal with in storm time. As to the detritus tanks, I notice they are formed in a very economical way. The humus-tank is a very important matter. We have seen in a good many works, however good the sedimentation tank and the percolating filters are, there is always trouble at the other end.

MR. E. WITTON BOOTH: I have very great pleasure in seconding the vote of thanks proposed by Mr. Mawbey to the readers of the papers. Undoubtedly the most interesting feature of the sewage disposal works is the distribution over rectangular beds by mechanically driven distributors actuated by electricity, and controlled in the manner stated, as these are so different from the system of distribution which most of us are accustomed

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to, viz. revolving sprinklers actuated by their own head similar to those seen at the Croydon Meeting last year, and at many other works elsewhere. Mr. Raikes' paper, I am sure, will be welcomed as a very valuable addition to the transactions of the Institution. With respect to the waterworks, I would have liked a little more detailed information as to the Meerbrook Sough scheme shared between Heanor and Ilkeston. However, perhaps on a future occasion we may have the opportunity of going over these works.

Mr. E. H. Crump: I should like an explanation of the cause of the tremendous amount of leakage from the water mains. It is given in the paper as reduced to 25,000 gallons per diem, and that quantity worked out at 6*d.* per thousand gallons, means a loss of 200*l.* per annum. Probably this has something to do with the loss of 460*l.* per annum on the Waterworks Department. I should like to know the cause of this leakage, whether it is due to subsidences from the collieries, or from bad workmanship in the jointing. I should also be obliged if Mr. Kilford would state the estimated cost per thousand gallons for softening the water. I see the hardness of the water is 22°. My authority is considering the matter at present; we have a total hardness of about 32°. The figures will be very interesting to me if Mr. Kilford will give us the information.

Mr. C. A. Clews: I should like to ask what the joints of the pipes are, how they are made, and where the leakage occurs. At Derby I was interested in the Meerbrook Sough scheme, as I was engaged in the necessary Parliamentary surveys for the scheme when Derby was thinking of having the water. Unfortunately we dropped it as there was a scare as to the pollution of the water, which proved groundless. Derby lost a very good thing when we lost that supply.

Mr. E. J. Elford: What strikes one in reading Mr. Kilford's paper are the tremendous difficulties which he has had to overcome, and the knock-down blows the Council have had from time to time with regard to the water undertaking. They seem to have displayed great courage in pulling through their difficulties. I think Mr. Kilford is to be congratulated upon the plucky way in which he has stuck to things. I should like to ask as to the boring referred to in the paper. The cost is given as 1615*l.* Mr. Kilford says the energy from the water might be used for generating electricity. As he requires 70 feet head

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after using the power it reduces his available head to 170 feet. I should question, having regard to the quantity of water, the utilisation of the energy for the purpose mentioned being found a paying proposition. As regards the sewage disposal works, one point which strikes me is that the distributors are capable of discharging a maximum of one million gallons per acre. That seems a very low maximum for the bacteria beds. I should have thought they would have been capable of dealing with a much greater quantity. In the tramway paper, I notice that Dicker joints were used in the construction of the permanent way. I am not surprised they have been a good deal of trouble; other people have had the same experience. I have used some of the Atlas joints, which have since been adopted, and I think they are likely to prove satisfactory. I think, however, the Thermit welded joints are likely to prove even better, though of course they are much more expensive.

MR. CHARLES F. WIKE: In going through the three papers I noticed the point already referred to, that the total flow of sewage is only 25 gallons per head per day, and should like to ask Mr. Raikes what provision is made for the storm water. It is now well known that the Local Government Board ask for provision for six times the dry-weather flow. In the contact beds I notice a large quantity of granite has been used. I am now completing a scheme, including 30 acres of contact beds, and 16 acres of storm-water beds, and, after a long experience, have come to the conclusion that slag, and furnace and destructor clinker are the best media to use. As the 46 acres of beds require 200,000 tons of material, the price is of some consideration. There are large works, similar to those of the Stanton Iron Company, in the immediate neighbourhood, one of which has a large heap containing approximately a million tons of old slag and refuse, and from this heap contractors are supplying 100,000 tons. About 180,000 tons have been placed in the beds from various sources at a price of from 2*s.* to 3*s.* per ton. It will be seen, therefore, that this question of filling material is a very important one, as the difference between 2*s.* and 3*s.* per ton for slag, and 8*s.* to 10*s.* a ton for granite, means an enormous amount in the cost of works, in this case at least 40,000*l.* or 50,000*l.* In a district like this, where slag is not difficult to obtain, I should like to ask why granite has been used instead of the cheaper materials. I have also tried coal, which is cheaper than granite

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but it was a failure because of the smooth surface. This would, however, to a certain extent apply to granite. The Author's reply, I suppose, will be that granite, when once put down, will last for ever, while slag is very friable, also that not all kinds of slag are suitable. This, however, depends on the selection, and whether it is acid or basic slag. The basic is no use, because after a time it is friable, and crumbles away under the influence of the atmosphere. I wish to add my thanks to those already given to the Authors of the papers.

Mr. R. Oakden: Sometimes slag will set together in a solid block. I do not know whether Stanton slag will do that. If so, it is rather an objection, in a sewage filter. I have seen large blocks taken out of a filter consisting of slag set in a solid mass.

The President: I have the honour of putting this vote of thanks to the Authors of the three papers, and I would like to say how much one appreciates the work of Mr. Kilford, particularly in relation to the difficulties of his Council in obtaining an efficient water supply. I am told the supply now is admirable, and answers every purpose. In that the Council are to be congratulated, and Mr. Kilford in particular. We have in these three papers useful information which will be supplemented by visits to the works. I should rather like to supplement the remarks of Mr. Wike as to the dry-weather flow. A week ago at Grays, in Essex, we had a capital paper by Mr. James. He had a table recording very accurately the gauging of his sewers, and, speaking from memory, I do not think there was a single day in the year when the flow had exceeded five times the dry-weather flow. This is most interesting to members, and should be of value in dealing with this question of the provision for storm water.

Mr. H. P. Raikes, in reply, said: I must thank you for the most kind way in which you have received my paper. The description of the works is intended to give you some idea of what you are going to see this afternoon, which will be further explained later by myself and Mr. Wright, the resident engineer, who has now the honour of being one of your Associate Members. I will not occupy your time by unduly lengthening my reply. The figure of 25 gallons per head per day is mentioned as apparently indicating a very weak sewage, and the small quantity of sewage at present going through the filters per yard as indicating that the filters have very little to do. The reason for

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having a comparatively small quantity per yard is that the sewage is strong and not weak. The water supply per head has been given as 17 gallons per day, so instead of being a weak sewage we have an exceptionally strong one. The separate system of sewerage is not installed in this town, so it is necessary not only to deal with the sewage, but the surface water at the same time. Mr. Mawbey spoke of the detritus tanks, and the arrangement of the sewage tanks generally. This can be seen in the illustrations, and I need only remark that we do attach the greatest importance to the efficiency of the preliminary tank treatment. We know that in some instances disaster has happened from trying to make the bacteria beds do the work for which the tanks are designed. Mr. Booth said he was interested in the system of distribution by mechanically-driven travelling distributors. That is, perhaps, the principal feature in these works, and they have been selected by the corporation of Ilkeston as being suitable to the conditions here, and we wish to take every possible precaution against the disadvantages arising from the spraying of sewage in the air when it is anywhere near to habitations. So we have adopted a system of discharging the sewage near to the filter where there is the least possibility of causing any nuisance. The distributors are by no means complicated, but in the illustration you will notice the distributing arms are deeper at one end than the other. That is done with the object of reducing their weight, and facilitating even distribution. It does have the effect of making the arm higher at one end than the other, but that does not make uneven distribution; it is perfectly even, and we get the sewage discharged at a uniform rate over the whole filter. The works are now only just being brought into operation for testing purposes, and have not yet been formally opened, so that although we are obtaining an effluent which is better than we expected at this early date, you must not think it is the effluent which we shall ultimately obtain. The question of the maximum quantity of sewage dealt with on the filters has been raised. The statement in the paper is correct that the filters are designed to work at the rate of one million gallons per acre, per day, which is the rate we find satisfactory, and the distributors can easily be adjusted to increase that rate if it is found desirable to do so. The need of provision for storm water is important, and we have satisfied the Local Government Board

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by dealing with storm water in a separate tank before discharging it into the river. The question of the material for filters is the most important of all, because costly works are sometimes built and then filled with rubbish. To facilitate a test of the material we have filled some of the filters with slag. The price is lower than even the figure Mr. Wike has mentioned, but we have not used a larger quantity of slag because we feel it is in the nature of an experiment. We have tested it very thoroughly, and we have had it analysed, and know exactly what its composition is, but we hardly felt justified in using it exclusively on so large a plant. There was also another reason—that it was not possible to get the quantity we required cleaned and screened at the rate we needed it. Time was a matter of great importance, and we had not the time to get one material for the whole of the works. We got different materials, and it will give us the opportunity of comparing results which will be of use. Mr. Oakden asked whether the slag showed any tendency to solidify into blocks. There is no indication of that. I could imagine it would happen with slag which has a very large quantity of lime in it, as the lime would form concrete. Mr. Thomas has mentioned the importance of records of the flow of sewage so that we may know what the works are doing. That is a point we have realised, and emphasised, and we are arranging for the automatic recording of the sewage flow at the inlet of the tanks, and another recorder registering how much of it is treated in each section of the bacteria beds. We are able in that way to so regulate the work that we can get the best results from each section of the plant.

The President: Mr. Stokes's paper is clear, concise to the point, and needs no discussion. If I might for the moment say so, it strikes me as a paper in which open confession is made, and I think you will agree with me that we often learn more from failures than we do from brilliant successes. Mr. Stokes tells us exactly the condition of things, and it is interesting to all of us to read this paper on tramways, which are very much in the eye of the public at the present time.

Mr. H. P. Stokes said: I wish to add my thanks to those of the previous speaker for the kind way in which you have received my paper. My paper is somewhat off the beaten track of this Institution. The only two references which were made on the paper were with regard to the electrical plant

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at the sewage works, and the joints of the tramway rails. With respect to the former, I have interested myself very much indeed, and I think Messrs. Willcox and Raikes will have every reason to be proud of the scheme when it is in full operation. The system of automatically operating the starters is somewhat unique, and is, I believe, the first system of its kind to be introduced in this country, and there is no doubt a very great field for this. With regard to the joints, as every tramway manager knows, these are a very expensive matter, but in our case, the "Atlas" joint works out at only 25*s.* to 30*s.* each complete. Now, imagine what the cost is going to be to the Corporation if we used the "Thermit" joint. Even on a small system of this size, there are about 1200 joints, so that if you take the increased cost of the Thermit joint, and multiply it by this figure you will realise what this means. Further, our joints are what is known as the "Dicker" rail joint, and it is impossible to satisfactorily use the Thermit method on this type of joint. The main point of my paper is to emphasise that on every job the whole trouble is caused through not maintaining efficiency from the start. In connection with the new sewage disposal works, if that job is neglected at the start it is going to be a rotten job for some one in the future. I think we should emphasise to Councils that we must keep a job up to full concert pitch from the beginning if it is to be worked economically.

MR. RAIKES: Mr. Stokes has been of very great assistance in connection with the electrical equipment of the sewage disposal works. We realise it and appreciate his assistance.

The afternoon was devoted to an inspection of the New Sewage Disposal Works, fully described in Mr. Raikes' paper. Mr. Willcox and Mr. Raikes accompanied the Members over the works.

Tea was provided at the Town Hall.

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NORTH WALES DISTRICT. MEETING AT WREXHAM.

October 19, 1912.

Held in the Lecture Hall of the Free Library, Queen Street, Wrexham.

R. J. THOMAS, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Mayor of Wrexham received the Members and offered them, in very cordial terms, a hearty welcome to Wrexham.

The President thanked the Mayor for his kind welcome which he had given to the Members of the Institution.

The election of an Executive Committee was then proceeded with. Mr. W. Jones proposed that the members of the North Wales District be the Executive Committee. This was seconded by Mr. E. Evans, and carried unanimously.

WREXHAM AND ITS MUNICIPAL WORKS.

BY J. ENGLAND (*Member*), BOROUGH ENGINEER, WREXHAM.

Historical.—Wrexham is a market and manufacturing town situated in the north-east corner of Denbighshire, having as its western boundary the famous Offa's Dyke of ancient history. The local historian, Mr. A. N. Palmer, in his book, "The History of the Town of Wrexham, its Houses, Streets, Fields and Old Families," states that the name is derived from Wrocansaetan, or the people round the Wrekin, a well-known group of hills situated in the adjoining county of Salop. The

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parish church, built previous to the year 1220, is one of the seven wonders of Wales, and is well worth a visit, the tower being a magnificent piece of architecture.

Physical Features.—The subsoil consists chiefly of drifts composed of gravel and boulders, overlying the Permian sandstone. Sand and clay are also found in places. The surface levels vary considerably, the mean being 275·0 above O.D.

General Statistics.—Incorporated, 1857; area, 1305 acres; population, 18,379; number of houses, 3849; birth rate, 25·8 per 1000; death rate, 14·3 per 1000; rateable value, 77,968*l.*; rates: poor, 5*s.* 4*d.*, general district, 3*s.* 5*d.*

Industries.—The principal industries carried on within the borough are brewing, tanneries, flour mills, and leather works; but in close proximity to its boundaries are collieries, steel and terra-cotta works, and it is owing to the large population within a radius of three miles of the town, *i.e.* over 50,000 inhabitants, that Wrexham has grown to be the premier town of North Wales.

Roads.—There are at present 20½ miles of public highways, of which 3¼ miles are main roads; there are also 3 miles of unadopted streets. The County Council contribute the sum of 848*l.* towards the maintenance of the main roads, and in addition pay the principal and interest, amounting to 135*l.* per annum, on a loan, covering a period of twenty years, for the paving of a length of main road 2½ furlongs in extent. The Author experiences considerable trouble in the maintenance of the roads owing to the constant openings made by the various public authorities having statutory powers, and during the last twelve months the length of mains and services laid along the carriage-ways alone amounts to over 1300 lin. yards. Arrangements have been made whereby the Corporation undertake the final repair of street cuttings at prices which are sufficient to cover all expenses incurred. The streets bearing heavy traffic are chiefly coated with granite, the remainder with a whinstone obtained from a local quarry. Tar-painting the roads has proved very successful, crude tar being principally used, the penetration in some instances having been found to be as much as two inches. The Author is of opinion that streets having a gravel subsoil are the best for tarring, and if laid where the subsoil is clay the foundation requires to be well drained. It is found that two coats are required to make the surface water-

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proof, and considerable economy is effected both in maintenance, scavenging, and watering. The cost averages 1*d.* per yard for the first coat and ⅝*d.* for the second. The Author keeps a record of the cost of street repairs, and the average for a 3-inch coating of granite is 1*s.* 2*d.* per square yard and with whinstone 10*d.* per square yard.

Footpaths.—The main street footpaths are principally paved with York or 2½-inch concrete flags, and in several instances concrete *in situ* and chequered tiles, the two first named being principally used at the present time. The light traffic streets have tar-paved footpaths constructed with a 3-inch foundation of tarred destructor clinker and a 1½-inch topping of ¼-inch tarred slag, the average cost being 1*s.* 4*d.* per square yard. Trial lengths of granite treated with ferromac, tar macadam (both whinstone and granite), and tar-grouted granite have been laid; but, with the exception of the first named, all have been laid recently.

Street Improvements.—Wrexham, in common with most of the older towns, is suffering from a lack of wide streets, and during the last nine years over 10,000*l.* has been spent in widening and improving the principal traffic streets. The most important improvement of recent years has been the widening of Regent Street from 32 feet to 42 feet for a length of 200 yards, at a cost of 1500*l.*, towards which the Road Board contributed 800*l.*

Private Street Works.—The Act of 1892 has been adopted, and since 1904 the streets have been constructed to the following specification:—

Carriageways.—Foundation 9 inches of pitchers, hand laid, well rolled, and 6 inches of whinstone macadam (consolidated) of 2-inch gauge, well rolled and blinded with gravel or chippings, York channel blocks, 10 inches by 5 inches.

Footways.—York kerbs, 12 inches by 5 inches, with tar paving consisting of a 3-inch bed of tarred destructor clinker, and 1½ inch of tarred slag topping.

The average cost for a 36-feet road, excluding soil and surface-water sewers, is 7*s.* 6*d.* per foot of frontage. The work has of late years been carried out by administration.

Markets and Smithfield.—The markets were purchased in 1898, at a cost of 46,850*l.*, and consist of three separate buildings, viz. butchers, general, and vegetable markets, the annual income

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being about 3300*l.* The Corporation have also purchased at a cost of 6200*l.* with a view to extensions, properties known as Queen Square and Yspytty, the areas of these being 900 and 1440 square yards respectively, the first named being for the enlargement of the vegetable market, and the latter for the erection of a wholesale market. A portion of the Yspytty land has been leased for a term of five years to the Glynn Picture Company at a ground rent of 120*l.* per annum. The vegetable market has recently been greatly improved by covering over the large open space in the centre, at a cost of 1907*l.*, and it is intended in the near future to proceed with an extension of this market, along with the provision of a Corn Exchange, at an estimated cost of 5000*l.* The Smithfield covers an area of 3¾ acres, and cost, with land for future extensions, 6300*l.*, the whole of the pens, with few exceptions, having concrete *in situ* paving, and a large number of the pens are covered with galvanised roofing. The Author recommends concrete *in situ* paving for sheep and pig pens, but for cattle it is not suitable, owing to its slipperiness.

Willow Depôt.—The Willow Depôt, and the electricity works, refuse destructor, and baths comprise spacious and substantially built brewery premises, purchased by the Corporation from the late Mr. Peter Walker's Trustees for the sum of 8000*l.* The situation is admirable, being very central, and the depôt portion comprises stabling, cart-sheds, stores, workshops, and horsekeeper's house. There are two smaller depôts, used principally for the storage of material. The number of horses employed by the Surveyor's department is thirteen, including two light horses, suitable for fire brigade use, which are yoked and worked together as far as possible when not required for fire-brigade purposes. The average cost per horse, cart, and man per day is 8*s.* 4½*d.* The fodder allowed each horse per day is: Clover, 7½ lbs.; hay, 10 lbs.; oats, 8 lbs.; bran, 2 lbs.; and the cost per horse per week is 13*s.* 4*d.*

Baths and Gymnasium.—The baths were constructed in an existing building (forming part of the disused brewery already referred to). The plans were prepared by and the work carried out under the supervision of the Author's predecessor, and comprise plunge bath 60 feet by 24½ feet, with shower baths, dressing boxes, etc. There are four first- and five second-class slipper baths, and one vapour bath. The manager lives on the premises.

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The plunge bath is open from April 1 to October 31, the number of bathers last year being nearly twenty thousand in the aggregate. The slipper baths are open the whole of the year, and are well patronised. The water supply for the plunge bath is obtained from a public spring, known as the Brynyffynon Well, a line of 4-inch cast-iron pipes being laid therefrom, a distance of 550 yards, along the bed of a small river that passes close to both spring and baths, and flows by gravity into an underground tank at the electricity works, from which it is pumped into an elevated storage tank of 20,000 gallons capacity. The electricity department provide the steam for heating, and do all pumping required for the baths department for the sum of 50*l.* per annum. The plunge bath is emptied twice weekly, the water supply from the well being sufficient to enable this to be done. Land has been purchased for the provision of an additional plunge bath, and sketch designs for same have been prepared by the Author, but up to the present nothing further has been done. The gymnasium adjoins the baths, and is fitted up with the necessary appliances, and when first opened was well patronised, but of late little interest is taken in it by the public.

Refuse Removal and Disposal.—The refuse collection is carried out by day work at present, but the Author has recommended his Council to adopt the piece-work system, as he is of opinion that this is the best means whereby the cost of collection can be kept within reasonable limits. The collection is weekly where portable bins are provided, and monthly where ashpits exist, but it is hoped that in a short time the whole of the houses will be provided with bins, the conversion to bins by the property owners being at a rapid rate. The shop refuse is collected daily without extra charge. The wages of the ash-men are 21*s.* per week, with the leading hand 2*s.* per week extra. The refuse is destroyed in a four-cell Meldrum destructor, erected in 1901, which adjoins the electricity works, and is in the charge of the electrical engineer. The cost of burning is borne by the Health Committee who receive 150*l.* per annum from the electricity department for the steam generated. Owing to the refuse not having been weighed previous to June this year, the cost for collecting same is uncertain, but averages 3*s.* 6*d.* per ton, the amount destroyed being approximately 135 tons per week and the cost 1*s.* 4*d.* per ton. The residue from the destructor averages 33 per cent. of the refuse tipped, and of this 10 per cent. is hard clinker.

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Electricity Supply Department.—The works were opened in 1901. Originally three 120 k.w. sets were installed, with a surface condenser and two Babcock boilers of a capacity of 200 H.P. each. In 1903, extensions to the generating plant were found necessary and a 300 k.w. set was installed, with the necessary boiler and condenser, the boiler being of a similar type to those already installed. Each of the Babcock boilers was fitted with superheaters. Since 1907, the generating station has been thoroughly reconstructed and brought up to date. At the beginning of 1908 a 60 k.w. set was installed, consisting of a Lancashire dynamo and Belliss engine; this for the purpose of doing the street lighting night load and subsequently to do traction in conjunction with a battery. A superheater was also fitted to the destructor boiler and a set of economisers has been installed. The engine-room has been extended, and one of the original Willans' engines has been fitted with automatic expansion gear and a second dynamo coupled to the end of the shaft. This enables both traction and lighting to be run from one engine. A new switch-board of an unusual type has just been erected; a particular and special feature about this board is that there is no combustible material on the rear of the panels, bare copper being used throughout. The number of consumers at present connected equals 354, and the connected load, exclusive of street lighting, equals approximately 33,200 30-watt lamps. A supply is also given to tramways, which are controlled by the Wrexham and District Electric Tramways Company. For the year ended March, 1912, the current supplied was as follows:—

Private supply lighting	234,664 units.
Power	129,486 "
Tramways	165,114 "
Public lighting	181,030 "

The accompanying schedule sets out the rate of increase and financial progress during the last seven years:—

Year ending.	Units sold.	Increase.	Loss. £ s. d.	Profit. £ s. d.
March 1906	409,074	81,687	957 1 1	—
" 1907	425,235	25,161	190 17 2	—
" 1908	485,886	60,651	—	11 5 8
" 1909	536,284	50,398	—	569 17 1
" 1910	548,711	12,427	—	342 13 5
" 1911	646,877	98,166	—	503 6 8
" 1912	710,500	63,623	—	375 0 0

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The borough electrical engineer is Mr. W. G. Pickvance, A.M.I.E.E., by whose energy and professional skill the undertaking has been placed upon a thoroughly sound and satisfactory profit-earning basis.

Public Lighting.—The street lighting is by both gas and electricity, the total number of lamps being 375, and the total cost 1936*l.* The whole of the gas lamps are fitted with incandescent burners, and the average cost per lamp with 5 feet burners, including renewals and cleaning, is 2*l.* 11*s.* 3*d.* per annum, the lighting hours being 3345, and gas costing 2*s.* per 1000 feet. The electric lighting is by means of 45 high-candle-power metallic filament lamps of 600 watts in the principal streets, each costing 20*l.* per annum, the smaller lamps being fitted with metallic filament lamps, averaging 75 candle-power, the cost per lamp being 3*l.* 3*s.* Automatic switches have been fitted to twenty of the gas lamps as an experiment, and up to the present have been found very reliable, and it is hoped to extend this system to the whole of the lamps on the outskirts of the town in the near future.

Fire Brigade.—The fire station adjoins the Guildhall, the appliances consisting of a 350-gallon steamer, manual, hose cart, and two fire escapes, the largest being 56 feet high, and is of the self-supporting type. The brigade consists of superintendent and twelve men, the superintendent and one man being permanent. The men are paid 1*s.* 6*d.* per drill, twenty-six drills per annum, and on Bank Holidays four men are specially retained for the day. The whole of the men's houses are electrically connected. At the rear of the station is the recreation room, with billiard and card tables, which is a means of attracting the firemen to the station in their spare time, thereby increasing the efficiency of the brigade to a considerable extent. The water supply is in the hands of a company, the Corporation, until recently, paying 4*s.* per annum for each hydrant; but they are now in negotiations with the company for the purchase of these hydrants. The pressure in the mains averages 35 lbs. per square inch.

Abattoirs.—The public abattoirs are situated at the Holt Road depôt, on an area of 2½ acres belonging to the Corporation, and consist of eight separate slaughter-houses and lairages. The buildings, having been erected about the year 1864, are not in a condition to fulfil present-day requirements, and the Author has

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been instructed to prepare plans for the erection of abattoirs on the most modern lines, and hopes that the same will be prepared in time for those members of the Institution attending the meeting to inspect and criticise.

Public Conveniences.—Since 1903, the whole of the public conveniences have been reconstructed on modern lines, and in addition, an underground convenience, comprising six stalls and two W.-C.'s, and three overground conveniences, with a total of twenty stalls, have been added. The returns from the W.-C.'s in the underground convenience is more than sufficient to pay interest and sinking fund on the loan raised for its construction.

Parks and Open Spaces.—The town is well provided with "lungs," the chief being "The Parciau," comprising an area of 17½ acres, which is being laid out as a park and recreation ground under the directions of the Author to a design prepared by Messrs. Cheale and Co., of London, in a prize competition. Up to the present, the entrance gates, railings, and lodge have been completed to plans prepared by the Author.

The William Jones recreation ground was presented to the town by John Jones, Esq., in memory of his brother, together with 650*l.* to defray the cost of erecting boundary walls, fencing, shelter, and laying out the ground in accordance with plans prepared by the Author, the area being 2½ acres. The beast market, purchased for an open space from the Crown in 1898, comprises an area of 1½ acres, and was used until the Smithfield was constructed as the cattle market. The annual pleasure fair is now held thereon, which brings in a revenue of over 200*l.* per annum.

Cemetery.—The cemetery, established in 1876, originally comprised an area of some five acres or so, and two extensions have since been carried out, the last in 1908, when a 12-acre field was purchased to be laid out as required to plans prepared by the Author, but up to the present it has only been necessary to enclose about one acre of this land. It will be of interest to know that it has not been found necessary to lay down any drainage in connection with the cemetery, the land being gravel throughout.

Main Sewers.—The main sewers were laid about forty years ago on the combined system from plans prepared by the late Sir Robert Rawlinson, the main outfall to Hafodywern being circular 30 inches in diameter. There are about twenty-one miles of brick and earthenware sewers in the borough, the whole of which discharge by gravitation. Owing to the old earthenware sewers

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being laid with clay joints, and in several instances with half collars only to the pipes, there is a very considerable amount of infiltration of subsoil water. All new streets constructed since 1904 have surface-water sewers in addition to foul-water sewers. The whole of the sewers are flushed monthly, by means of a 400 gallon van. There are no privies within the borough, and with the exception of four isolated houses the drainage of every house is connected to the sewers. The system of ventilation is by means of shafts and Webb's sewer lamps, the manholes with few exceptions having closed covers.

Sewage Disposal Works.—Previous to 1890, the sewage disposal works were situated at Hafodywern and consisted of three shallow sedimentation tanks about 190 feet in length, the effluent afterwards passing on to the Hafodywern Farm, where it was distributed by broad irrigation. In 1889, owing to the Hafodywern Farm being insufficient to deal with the whole of the sewage, the Corporation leased for a period of 99 years Five Fords Farm, which is situated about two miles south-east of the borough and to which the sewage is conveyed from the Hafodywern tanks by means of a 15-inch sewer. In 1903, the Author's predecessor (the late Mr. J. W. M. Smith) prepared plans for the entire reconstruction of the sewage disposal works and recommended that new sedimentation tanks be constructed at Five Fords Farm, and that storm-water filters be constructed at Hafodywern to deal with the excess over three times the dry-weather flow. The works consist of detritus chambers and three sedimentation tanks, each 120 feet long and 24 feet wide, and have a total capacity of 300,000 gallons. Previous to entering the tanks the sewage passes through an automatic revolving screen worked by the flow of sewage. After passing through the tanks the sewage flows along underground carriers to various points on the farm for treatment by broad irrigation, chiefly on the ridge-and-furrow system. The farm has an area of 210 acres, of which 180 acres are available for sewage treatment, but 108 acres only are underdrained up to the present. The subsoil for the greater part is loamy sand and gravel. The tanks are constructed throughout of concrete, the aggregate consisting for the major portion of clinker from the refuse destructor, and it is of interest to mention that the works do not show the slightest signs of fracture. The storm-water filters at Hafodywern consist of four beds with a total area of 2240 sup. yards,

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and provide for the treatment of 1,120,000 gallons per day, the filtering medium being destructor clinker 4 feet deep. The sewage is chiefly domestic, with a considerable quantity of chemicals from leather works and brewery waste. The dry-weather flow averages 1,145,000 gallons per day, of which it is estimated 425,000 gallons only is domestic sewage, the remainder being trade waste and infiltration water in the proportion of two-thirds and one-third respectively.

Owing to the regrettable death of Mr. Smith on the eve of commencing the construction of the works, the Author was appointed engineer, with the late Mr. J. T. Eayrs, M.Inst.C.E., as consultant.

DISCUSSION.

Mr. W. Jones: I am sure there are points in this paper which will give us valuable information as to the cost of various municipal works in a town like Wrexham. I find Mr. England experiences the same difficulty as I have in Colwyn Bay, of having roads cut up by various irresponsible authorities and persons, with the consequent onus accruing from the ill-effect of the repairs on the ordinary surface of the road. I notice Mr. England says, "Arrangements have been made whereby the Corporation undertake the final repair of street cuttings at prices which are sufficient to cover all expenses incurred." I should like to know if Mr. England has got out any standard price for such repairs, as it might be a guide to other surveyors as to what they ought to charge. I can assure you this is a very serious matter; these irresponsible departments seem to think they can do what they like with a road. I should like to know whether the payment is on the amount of work executed in the repair of each opening or so much per square yard. I must call attention to Mr. England's cost of road maintenance. He says the average for a 3-inch coating of granite is 1*s.* 2*d.* per square yard, and with whinstone 10*d.* per square yard. Mr. England and myself are both in the same county, and I cannot convince the County Surveyor that it costs anything like that price. On the last estimate the County Surveyor was only prepared to grant me 7*d.* per yard. Mr. England's figures show that it cannot be done at that price. It is stated that all new streets constructed since 1904 have surface-water sewers in addition to

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foul-water sewers. I should like to know what precautions Mr. England takes against builders and others connecting up say the foul-water drains to the surface-water sewers. Is it left to the people themselves to make the connection with the sewers, under the supervision of an inspector? With reference to the ventilation of sewers, the system is said to be by means of shafts and Webb's sewer lamps, the manholes, with few exceptions, having closed covers. I should like to know if Mr. England has any figures to give us of the cost of maintaining these Webb lamps. As you know, our usual custom is to advise our authorities to erect ventilating shafts. I have several ventilating shafts, but I still get complaints of smells from the sewers, and I should like to know whether the use of Webb's lamps has cured the effusion of smells from the sewers. I have much pleasure in proposing a vote of thanks to Mr. England for his paper.

Mr. Evan Evans: I have much pleasure in seconding the vote of thanks to Mr. England for this clear, concise, and excellent paper. Having lived some years ago in this locality, perhaps you will permit me for a moment to go off the straight line of the paper. I am delighted to find Mr. England's capabilities expanding and growing even more than the town. I knew his predecessor, Mr. Maxwell Smith, very well. He was a man much liked, he was here a long time, and did his work well. When Mr. England came here, quite a young man, he had obviously a difficult task in succeeding so ripe and experienced a man. One is glad to find that not only did Mr. England make a good impression at the start, but he continues to impress the town in a manner creditable to himself, reflecting credit on the town in his work, and their choice and support of him. I shall only have a question or two to put with regard to matters with which I am more immediately connected. I notice that the County Council contribute the sum of 848*l.* towards the maintenance of the main roads, and in addition pay the principal and interest, amounting to 135*l.* per annum, on a loan, covering a period of twenty years, for the paving of a length of road 2½ furlongs in extent. I should like to know the principle on which the county contribution is based, and in particular what expenditure, if any, is paid back in full. Then I would like to know what proportion of scavenging is repaid, what proportion of watering is repaid, and, now that tarring is so much in vogue all over the country, what proportion of the tarring expense is

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paid back by the County Council. Then Mr. England states that the streets bearing heavy traffic are chiefly coated with granite, the remainder with a whinstone from a local quarry. Will he say from what quarries the granite is obtained—whether some is from Penmaenmawr and some from Clee Hill, if so, at what price it is delivered at Wrexham station; if he has had the opportunity of comparing these two granites side by side under equal or nearly similar conditions, and which of the two granites he prefers, giving his reasons? We have the price of tarring very clearly in the paper, but I should like to know the price paid for the tar. Mr. England says the average cost for a 36-feet road, excluding soil- and surface-water sewers, is 9*s.* 6*d.* per foot of frontage, but I should like Mr. England to make it more clear. Does it mean 9*s.* 6*d.* per foot of street, or is it 9*s.* 6*d.* per lineal foot of building frontage found and measured on both sides of the street? With reference to team labour, Mr. England says the average cost per horse, cart, and man is 8*s.* 4½*d.* per day, and a little further on he says the average cost per horse per week is 13*s.* 4*d.* There is a good deal of difference between 8*s.* 4*d.* per day and 13*s.* 4*d.* per week. In the first place there is the man, but there does seem afterwards some disparity between the figures. I am pleased to second the vote of thanks to Mr. England.

Mr. G. W. Lacey: With regard to the trial lengths of granite treated with ferromac, tar macadam (both whinstone and granite) and tar-grouted granite, even though Mr. England states it has been laid recently, I should like to ask what are the apparent results from these up to the present time—that is, comparing the three materials. I tried ferromac some time ago, but I have not used it since. Perhaps Mr. England would give us a little further information as to how these different trial materials are progressing. With regard to the new streets, the price of 9*s.* 6*d.* per lineal foot, considering the method of construction, does seem a little heavy in cost. Six inches of metalling after consolidation strikes one as a little extravagant in thickness if the streets are suburban streets and not subjected to heavy through traffic. This price does not include soil- and surface-water drains, but I would like to ask whether it includes gulleys thereto and their connections. That is not stated. Mr. Evans asked a question as to horse-keep. I take it the 13*s.* 4*d.* per week is for horse keep alone, and does not include stable charges and

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veterinary attendance, etc. I find the cost at Oswestry, with the present price of fodder, is 7*s.* 8*d.* per day for horse and man. With regard to the collection of the refuse by piecework I should like to have some indication of the method, and whether Mr. England is prepared to recommend the same system. It seems a little bit difficult to arrange. I should like to ask whether it is so much per ton, and is it done by the Corporation staff? Mr. England states the wage paid to the ashmen. What is paid to the drivers? It would help to show how the 8*s.* 4*d.* per day is made up.

MR. J. PRICE EVANS: There have been great strides made in Wrexham and the surrounding district during the past twenty or twenty-five years. Our health statistics, both for the town and district, are very favourable indeed. There are few places which can boast a lower death rate. Some years ago the sewage system of the town was in a very bad state. The Council called in Colonel Jones, who introduced the broad irrigation system at the farm. Wrexham is very fortunate indeed in having such a farm, and in having land so situate and so suitable for a sewage farm. For my own part I am not very much in favour of sewage farms; but, on the other hand, if you have to deal with a large population like this on any other system it would mean a heavy expense to the borough. When Colonel Jones introduced this system of broad irrigation at Hafodywern, it worked very satisfactorily, but as Wrexham has increased in population very considerably, and will increase still further, no doubt before long the sewage farm will have to be enlarged. Everything at the farm seems to be very satisfactory. We happen to be in the fortunate position of having a very good tenant to look after the land. But, after all is said and done, every man will look after himself; and will regard the farm from the point of view of the crops rather than the treatment of the sewage; but I think on the whole Mr. Bellis is a very good tenant, and the sewage farm is very satisfactory indeed. With regard to the ventilation of sewers, etc., there is a gentleman who was once connected with this borough, and became Mayor, Mr. Isaac Shone, who has done a great deal for the town. In days when town planning was hardly thought of, I know I spent much time in preparing plans for the construction of proposed new roads through the borough. Several of those roads are constructed at the present time, and no doubt through Mr. Shone's inception. Mr. Shone is now preparing, and I hope he will be

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spared to publish, a book on the ventilation of sewers and sanitary engineering generally.

MR. HAROLD COLLINS: With regard to the openings cut in the roads by the various authorities and companies in Norwich, our custom is to send a circular letter to all the public authorities—gas, water, electricity, tramways, and owners of property—informing them of the Corporation's intention to carry out repairs, and requesting them to get any connections or repairs made previous to the repair of the road. A notice of three months is given. We find this very satisfactory. I find our street repairs cost more than those of Mr. England in Wrexham. Our granite roads cost 1*s.* 5*d.* per yard, against 1*s.* 2*d.* The cost of the granite is 12*s.* per ton. Our private street work is the same, 9*s.* 6*d.* per lineal foot of frontage, with granite kerb and bituminous surface. Our cost for horses is practically the same, 13*s.* 2*d.*, against 13*s.* 4*d.* The cost per horse and man is 8*s.* 10*d.* per day, as against 8*s.* 4½*d.*, our wages being slightly higher. I am sorry to see the gymnasium is not very well patronised. We have had a gymnasium in Norwich for two years, and we shall probably have to extend it. We have classes for boy scouts, training brig boys, etc., also works and private classes, and a paid instructor, who gives his whole time to it. We get more applications for classes than we can deal with. I was very interested in the sewage farm. Mr. England is very fortunate in getting such a good sludge. We have a great deal of trouble with our sludge. We get a large amount of trade refuse from the starch works and the breweries. Our sludge is an emulsion, and we cannot press the water and fat out. A company is putting in works at a cost of 10,000*l.*, to treat it on a wet carbonising process to press out the water and extract the fat, and sell the residue as a manure. I do not think there should be any danger of connection of the drains to the wrong sewer. In Norwich, we never allow anybody to make a connection to the sewers; the builders lay the pipes, but we make the connections. In water-logged ground we lay the pipes up to the waterline. In addition, we make a rigid examination of all work done.

THE PRESIDENT: I have very great pleasure in putting the vote of thanks to Mr. England for his admirable paper. I should like to support the vote of thanks very heartily. We have seen work very well done and very economically done. The sewage farm seems to me to be in admirable condition, and doing its

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work very well indeed. I was very much interested in the electric-light station. There has been very great ingenuity exercised in effecting economical work, which will be for the benefit and profit of the ratepayers. The roads are in very good condition indeed. Excavations in streets is a very difficult question. It is very desirable that some such step as Mr. Collins has referred to, should be taken of informing companies of prospective work to the roads; but even when this is done, there are innumerable excavations made in roads, and, however well repairs are done, there are always depressions in the surface. It seems to me the authority responsible for the roads should be the authority to restore the trenches. It does not matter what the arrangement as to cost is, but the ratepayers should not suffer as to the condition of the roads, or in pocket by excavations necessitated by private enterprises.

The vote of thanks having been unanimously accorded,

Mr. J. England, in reply, said: I thank you very much for your kind vote of thanks. I can assure you it is a very great pleasure to me to have the honour of preparing a paper to present at a meeting of this Institution. I only regret that the meeting has been for one day, and not for two days, as originally intended. Unfortunately, I fell ill just at the time when the meeting should have taken place, and it had to be postponed; and it was found that Mr. J. Price Evans, engineer to the Wrexham Rural Council, who intended joining me in the two days' meeting, was unable to do so in the present case. Mr. Jones, Colwyn Bay, has asked the cost of repairing cuttings in the roads. Previous to my coming here there was no definite price for the repair of cuttings, but I am pleased to say I have made arrangements with the gas and water companies for the payment of 1*s*. 6*d*. per lineal yard for services, and 2*s*. 3*d*. per yard for mains; but if a wider trench than 1 yard is to be cut, then the price has to be arranged with the engineer of the company. In many instances I have given three weeks' or a month's notice to the gas, electricity, and water people of my intention to repair a road, but immediately I have repaired it one or the other has come along and cut it up. It is most annoying. As regards sewer connections, the only precaution I take is that every connection is examined by myself or an assistant, so I do not think there is any danger of connecting a foul-water drain to a surface-water sewer. The price of maintaining a Webb's lamp is 4*l*.

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each burner per annum. These Webb's lamps have been a splendid thing in stopping complaints of bad smells. I had an instance about twelve months ago of a lady complaining that the light was out in one of these lamps, and that a bad smell was noticeable. I assured her everything was all right, and soon afterwards I met her and asked whether she had noticed any smell since, and she answered "No." I myself thought the lamp was alight at the time, but it was not. That shows there is a good deal of imagination about smells from sewers. The price of gas is the lowest in Wales, 2*s.* per 1000 cubic feet. Mr. Evans (Carnarvon County) asked as to the contribution of the County Council for main roads. As regards the repair of the roads, they pay the whole amount expended; for scavenging, two-thirds, and for watering, one-third of the cost. The granite used is Penmaenmawr. I have a certain amount of granite from another quarry near Bala, but for the main streets Penmaenmawr is used. The cost is 9*s.* per ton, delivered. We do not ask the County Council to contribute towards the tarring of the roads. The price for crude tar is 35*s.* per ton. I have used a certain quantity of refined tar, but find the crude tar, which is of very good quality, quite suitable for the roads here. The cost of horse and cart, 8*s.* 4½*d.* per day, includes everything, the man, veterinary attendance, horsekeeper, etc. The cost of 13*s.* 4*d.* per week is simply the fodder. The cost of private street works as given in the paper is per foot of frontage and not per foot of street. Mr. Lacey asked my opinion of ferromac. I am sorry to say my experiences are the same as his. Ferromac has been a failure here. In the case of private street works the cost of gullies and connection is included in the amount given per foot of frontage. As to refuse removal, the system of piecework payment is similar to that being carried out at Chiswick. We pay the men, including the carter, for collecting, at so much per ton. The Corporation provides the horse and cart. The wages of the carters are 22*s.* per week. The rate of 8*s.* 9*d.* includes 2*s.* 2*d.* for the repayment of principal and interest on loans, poor rate, including Police and County rates. The rate of wages paid to labourers is 21*s.* per week. I thank you very much for the way in which you have received the paper.

The President: I will ask you to thank the Wrexham Council for the hospitality they have shown us, and the works they have given us the privilege of inspecting.

The vote of thanks was unanimously accorded.

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WREXHAM CORPORATION ELECTRICITY DEPARTMENT.

SPECIAL attention is directed to the new switchboard, which is nearly completed, and which, as mentioned in the paper, is of an unusual type. As the old board did not conform with the new Home Office regulations, and as the Home Office would not allow extensions to be carried out on the same lines, it was decided to obtain a new board, which should have a much larger capacity and be more up-to-date and safe in its operation. The old switchboard consisted of generating panels, having a total capacity on the generating side of 660 kilowatts, with about the same capacity of feeder panels, together with the necessary balancing arrangements.

Generating Panels.—The new switchboard consists of the following: Two panels of 600 kilowatts each, 1200 kilowatts; Four panels of 300 kilowatts each, 1200 kilowatts; total, 2400 kilowatts.

Feeder Panels.—The feeder panels consist of 6 pairs of 400 ampere switch and fuse gear, capable of dealing with, roughly, 1200 kilowatts. Space is left for the accommodation of, when required, 1000 more kilowatts in the form of two sets of switch gear.

The board consists also of public lighting section, capable of controlling twelve circuits, with works panels, containing a similar amount of gear. Accommodation is also provided for two 100 ampere balancers, also the usual earth and mid-wire panel. On this panel arrangements are provided for fourteen mid-wires. A circuit breaker is fitted for the protection of the earth recording ammeter, which is mounted on the same panel. Pilot lamps are fitted as danger signals to indicate when any serious earth eventuates.

On this panel will also be noted a main recording ammeter; this ammeter records the total amount of current sent out to the mains, and an interesting feature about the apparatus is that the shunt is fixed several feet away at a point where it can intercept the current between the generating bus-bars and the lighting bus-bars. The shunt being fixed at this point necessitates special leads, and this arrangement has been carried out in a very neat and satisfactory way by means of enamelled wire securely cleated to the back of the switchboard. The usual voltmeter arrangements are provided, and these are mounted on a

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pillar placed at the front of the switchboard. The special features of this board are—

1. The larger capacity in a very small space. It may be mentioned that we have secured practically four times the capacity of the old board in about two feet less space.

2. Safety and ease of control. The generating panels are designed for traction as well as lighting, and as the same switch gear is used for this purpose special arrangements have had to be made to obviate the risk of paralleling lighting and traction together. This device is very interesting.

3. The chief point, however, to call attention to, is the absolute immunity from fire risks. Switchboards are usually at the rear, cumbered with a mass of small rubber-covered cables. On this board such material has been entirely eliminated; solid copper has been used for all the small circuits, and, in addition to that, this copper has been enamelled. All leads are laid in diagrammatical form, and securely cleated to the slabs by means of porcelain insulators. Not only has this material been used for the small wiring, but it has been adopted also for ammeter shunts. Usually, these shunts are supplied with a couple of yards of rubber-covered flexible. By means of special arrangements and careful calibration the necessary shunt leads have been constructed of enamelled wire.

4. Shunt and Series regulators. Attention is also called to the manner in which this gear is assembled under the switchboard, and particularly to the controlling hand-wheels, bevel gearing, etc. Altogether, there are eight machines (including the two balancers), and this would, in the usual way, necessitate sixteen pillars, one pillar for the shunt regulation and one pillar for the series regulation in the case of each generator, with a pillar for shunt regulation and a pillar for starters in the case of each balancer. These pillars have, however, been reduced to eight, by means of a special concentric device, which consists of a central stem for the shunt regulation, while the series regulation for the generators and the balancer starters is operated from an outer sheath or tube. This arrangement enables all controlling apparatus to be directly in front of its corresponding switch gear, while it also saves a considerable amount of space.

As already pointed out, the generating gear may be used for either lighting or traction, a special changeover switch being fitted and so arranged that when lighting is required the switch

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is placed upwards, and when traction is required it is fixed in the bottom position. While the feeders are protected with ordinary porcelain fuses, the generators have on one pole an automatic circuit breaker, which protects the machine against short circuits on the feeders, as also a time element, which restricts the operation of the circuit breaker until a few seconds after the fault comes on. The breaker is also fitted with a reverse current device, thereby protecting the machine against reverse of current in the event of failure or breakdown in the generator when two or more are working together.

Attention may also be called to the special assembly of the bus-bars at the rear of the board, together with the vertical bus-bar work on the front. This bus-bar arrangement renders it possible to run any particular generator on any particular feeder, and if, therefore, a different pressure is required on any particular point, it is quite a simple matter to give this point its own generators by means of coupling up a separate pair of bus-bars. The arrangement of bus-bars provides also for the installation in future of reversible booster and battery for the lighting. Attention is also called to the method adopted for lighting the switchboard. Brackets are the usual thing on a board of this size, but the main girder against the ceiling has been utilised for reflection, and a series of lamps fixed to the girder. This gives clear and efficient lighting without any lamps being in the line of sight; the same method is also adopted for illuminating underneath the switchboard, the necessary lamps being fixed to the main front joist.

The switchboard was manufactured by Mr. Bertram Thomas, of Manchester, to the special design of the borough electrical engineer, Mr. W. G. Pickvance, A.M.I.Mech.E., A.M.I.E.E., while the platform was supplied and erected by Messrs. Hayward Bros. and Eckstein. The platform, it will be noticed, is of special construction, glass being used for the flooring, this giving good insulation and immunity from shock.

The Members visited the markets, the fire station, electricity station, and Willow depôt. The Mayor entertained the President and Members to luncheon at the Wynnstay Arms Hotel, when the Mayor presided. After luncheon, the Members proceeded in brakes to the sewage farm, which was thoroughly inspected. Mr. England entertained his confrères to tea at the Wynnstay Arms Hotel.

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METROPOLITAN DISTRICT. MEETING AT WESTMINSTER.

December 6, 1912.

Held at the Caxton Hall, Westminster.

R. J. Thomas, M.Inst.C.E., President, *in the Chair.*

The President: We have met here to discuss a paper prepared by Mr. Wakelam, on the vexed question of tram-rail corrugation. I should explain how this arose. The Tramway Committee of the Council have been very carefully considering this subject, and sent out a very formidable list of questions. You see on the walls the endless variety of questions, and also the large number of answers. These came to the Committee, and they felt they had to be put in the hands of somebody to tabulate. It is obvious that such work meant considerable time and a great amount of ingenuity, but Mr. Wakelam very kindly undertook it, and to prepare a paper upon the subject for this meeting. I trust that members will discuss this paper freely, and give us the benefit of their experience in the treatment of tram-rail corrugations.

RAIL CORRUGATION.

By H. T. Wakelam, M.Inst.C.E., F.G.S. (*Member*),
County Engineer, Middlesex County.

When accepting the invitation of the Council of the Institution to tabulate, and report upon, the returns received to the queries

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sent out by the Tramways Committee in connection with the above subject, the writer was not aware of the large amount of labour and time the work would involve—especially to one placed like himself, whose ordinary time is so strenuously taken up. It was only through a concession of a large portion of his limited leisure, that he was able to prepare the compilation of replies to the numerous questions (71) circulated to Engineers in charge of Tramway systems in the United Kingdom.

After preparing the somewhat voluminous compilation, which appears on the wall of this room to-night, it was necessary, before the writer could arrive at any degree of finality on the question, to prepare also an analytical tabulation, in a condensed form, to afford information sufficient to enable him to form any sort of conclusions as to the cause, or causes, of rail corrugation.

Even after preparing the compilation, and the analytical tabulation, it was an onerous and difficult task to deduce from them sufficient *data* from which any degree of opinion on the subject could be given. This may be judged from the many different views set forth in the answers received to the questions circulated, some of the Engineers replying, stating—

That corrugations develop most quickly on rails laid on rigid beds.
„ „ are most pronounced where the subsoil is plastic.
„ „ „ „ prevalent where the subsoil is water-logged.
„ „ „ independent of the nature of the subsoil.
„ „ „ independent of speed.
„ appear mostly on flat curves and straight tracks.
„ „ are more pronounced on outer rails.
„ „ „ „ „ where speeds are high.
„ „ „ „ „ where speeds are low.
„ „ „ „ „ where "coasting" is done.
„ „ „ „ frequent on gradients of 1 in 100 to 1 in 400.

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That corrugations are more pronounced at stopping places and on down grades.
" " " general on both up and down grades; and on both flat and steep grades.
" " appear on the outside rails of curves, and on the inside rails of straight tracks.
" " are most prevalent on flat tracks.
" " " found on manganese steel points.
" " appeared in one case, on a straight track only, and at one particular place only.
" " are most prevalent where brakes are applied.
" " " found in some places at an acute angle, but mostly at a right angle, to the rails.
" " " continuous where they occur.
" " " found on single tracks, where cars travel both ways.
" " " found on light tracks where the subsoil is both spongy and marshy.
" " appeared only, in one case, where the rails were originally packed on a concrete bed.
" " are found on the same formation on both up and down tracks.
" " " most marked where the carriageways are not paved from kerb to kerb.
" " " mostly intermittent, but in places continuous.
" " appeared in some places, altered in their wave-lengths, and finally disappeared.
" " are not found on both rails at the same place.
" " " found on inner rails, about double the length of, and slighter than, those on the outer rails.
" " do not appear where "coasting" is done, and where ordinary brakes are used.
" " are removed by cars.
" " " not found where the speeds are low.
" " " " " on ballasted tracks.

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That corrugations are not found on down grades.
" " " " influenced by slight differences in construction.
" " " " found where ordinary track brakes are used.
" " " " " to be more prevalent where the subsoil is water-logged, than otherwise.
" " " " " at stopping places.
" " " " " where the rails were originally laid in solid (puddled) concrete beds.

That loose rails tend to corrugation.
" corrugations in one system, practically disappeared where the rails were lifted and tightened to the track bed; and
" the trouble is not created by the use of ordinary brakes.

From the foregoing, and from the other information contained in the answers received to the questions circulated, it may be argued that the trouble is chiefly set up by combined influences, such as—

(*a*) The constant oscillatory motion of the car wheels on the rail surface; due (1) to high speeds; (2) to bogie cars; (3) to short wheel bases; and (4) to heavy car platforms.

(*b*) The rigid bed, which, for stability of the road surface, must necessarily be laid down. In this connection it can be assumed, with safety, that the more rigid the road bed the more intense the impact of the rolling stock;

And (*c*) curvature of track. In this connection it is clear that the curves, generally, of tramways, steam railways and electric railways, are affected by corrugation to a greater extent than straight tracks.

The aforesaid influences, conjointly with driving and braking, may be factors towards the trouble, although later in this paper the writer furnishes information which makes it exceedingly difficult for any definite opinion to be formed as to what is in reality its cause.

Speeds are much higher to-day than were possible with the old cable tracks, which tracks suffered from corrugation to a

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limited degree only. The trouble in this connection was always attributed to braking.

Constant and rapid braking, under the fast traffic of to-day, no doubt, cause varying and irregular impacts between the wheel tires and the rails. These varying impacts, with the influences already referred to, may have a considerable bearing on the question, especially when (what are known as) "wheel flats" are correlatively considered. It may be that vibration combined with the influences already mentioned may, also, have some bearing on the question. To prove the length of vibratory waves along tramway rails produced by varying speeds of rolling stock, the writer made actual experiments a few days ago on the Middlesex County system, and found—

That in connection with a car travelling at a speed of twelve miles an hour, the vibratory wave was *noticeable* on the rail head at a distance of 240 yards from the car.

That at a distance of 160 yards, vibration was general.

That at a distance of 70 yards, vibration was distinctly accentuated as the car passed over each joint, and

That vibration was not so pronounced on the curves as on the straight tracks.

Thicker rail webs than those commonly used on tramways would, no doubt, obviate vibration to some extent, and in this connection, lengths of track so constructed, may well be laid for the purpose of experiments, with both high and low carbon rails.

Very little corrugation appears to be noticed where the car traffic is of a light nature, and the trouble appears to increase in *ratio* to the traffic.

Tracks used by bogie cars are more corrugated than those confined to cars with fixed frames. This may be due to the oscillation caused by the small wheels of the former.

Tramway rails of the same section and make, subjected to the same tests, corrugate to varying degrees, and also vary considerably under actual wear. Rails supplied by firms in Barrow-in-Furness, Belgium, Leeds, Lorain, and Middlesborough, to one particular system of tramways, have been known to corrugate.

Corrugations (see illustrations) affect tramway rails laid on concrete beds of almost any strength or thickness. Corrugation is also experienced where the rails are laid on longitudinal wood

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sleepers (embedded in concrete)—for instance, the system of construction adopted in the town of Hull.

It was stated at the Paris Congress that from actual tests soft rails corrugated less than hard rails. The tests were stated to have proved that in comparisons of wear after the first 30,000 cars over the tracks, the result of the next 65,000 was in favour of soft rails. Hard rails are, however, universally accepted as being the most economical for general wear.

In reply to questions sent out by your Institution, it was stated (1) that in the town of Perth the trouble affects both rails, but, on one particular length of track only; and (2) that at Sunderland, corrugations appeared, and disappeared, on tracks where speeds were fairly high, and that, after disappearing for a time, they are again showing. In the latter connection, it would be of interest to know whether, or not, there have been alterations, or changed conditions, in the tracks, or rolling stock, or in regard to the speeds at which the cars travel.

Those Engineers who replied from the following towns, viz.: Accrington, Ashton-under-Lyne, Heywood, and West Bromwich, stated that the tramways there are not at all affected by corrugation. They appear to be exceptions to the general rule, and those members of the Institution, who are particularly interested in the subject, may, perhaps, like to make an inspection in those localities, with a view to ascertaining whether, or not, there are favourable, or local, circumstances, in regard to their immunity from the trouble.

There are, undoubtedly, unknown conditions attaching to the formation of corrugation which appear to be always in force. And it appears, also, to be the fact that there is some neutralising action which causes corrugations to appear and disappear. For instance, the case of the Sunderland tracks, already referred to, may well be cited.

The trouble does not affect the rail tread only. In some systems the wall faces of the grooves are also affected.

Being so much engrossed in the problem, the writer was impelled to extend the scope of his inquiries in the direction of permanent ways designed for steam and electrically driven trains. He is glad he did so, because the information gleaned, in this direction, forms not the least valuable portion of this paper.

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Rail corrugation does not confine itself to tramways only, it is also met with, very extensively, on both ordinary steam and electric railways, as the following notes show.

First, in this connection, it is of interest to know that corrugations are met with, to a considerable degree, on many lengths of such railways, and the illustrations accompanying this paper show the pitch and shape they take.

Illustration No. 1 shows corrugations with an inch pitch on one of the chief English railways under fast trains.

Illustration No. 2 shows an enlargement of the corrugations shown in No. 1.

Illustrations Nos. 3, 4, 5, and 6, show varying corrugations, on a line branching from one of the main trunk railways.

The trains passing over these lines are all *steam driven.* This fact altogether upsets the theory of those who state that corrugations are set up by electrolytic action.

In regard to tracks used by electrically driven trains, where the usual "side supported" construction has been adopted corrugations are constantly met with.

An important case having a great bearing upon the subject matter of this paper is that of an electric tube railway, in which case the track, which has been in use about six years, was constructed to the design shown in Illustration No. 8. Up to the present there is no sign of corrugation on either the curves or on other parts of the system. In contradistinction there is an electric railway, under the same control as the electric tube railway just mentioned, which was constructed on the ordinary steam track principle (Illustration No. 10). On the latter corrugations have proved most troublesome—especially on the curves—although the rolling stock employed is common to both No. 8 and No. 10 systems. The rails used in each case were identical, viz. Sandberg Silicon.

Owing to the successful results obtained by the adoption of the centre supported track (Illustration No. 8) on the electric tube railway referred to in lieu of tracks on rigidly supported beds (Illustration No. 9), it is, I understand, the intention of the Executive Engineer of another railway to reconstruct the whole of the system, of which he has charge, on the centre supported plan (Illustration No. 8). In his opinion, corrugations

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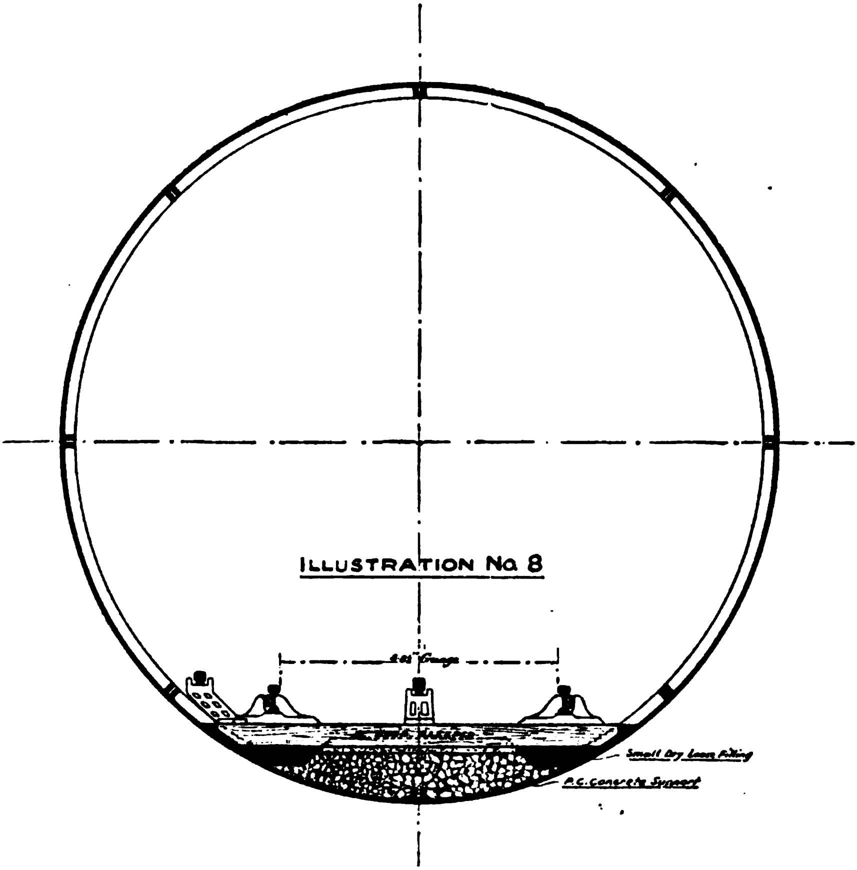


ILLUSTRATION No. 8

ILLUSTRATION No. 9.

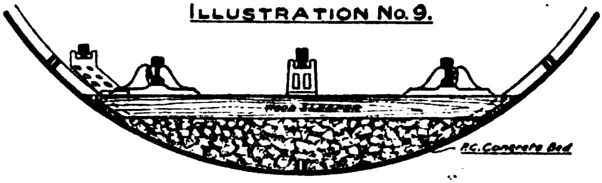
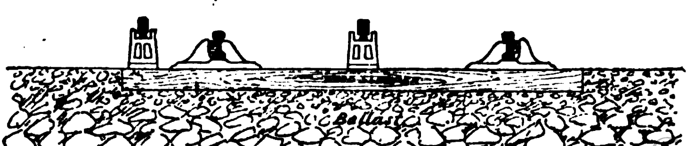


ILLUSTRATION No. 10.



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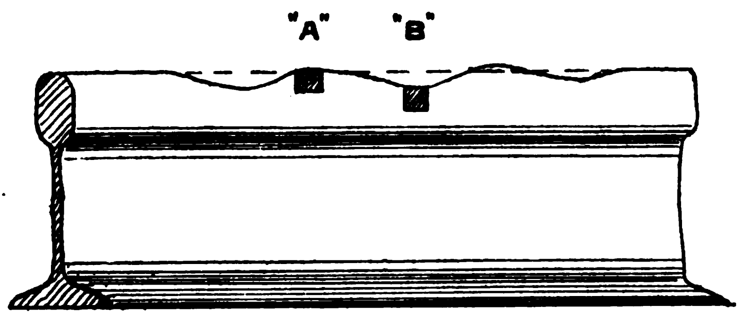
or "batterings" (which latter are, practically, fully developed corrugations) are due to rigid beds.

From the foregoing facts, notwithstanding anything previously referred to in this paper, it may be well assumed that the principal cause of the trouble arises from, or in connection with, track construction.

An experiment recently carried out on a curve of ten chains radius (on an ordinary ballasted railway track) affords ground for reflection. Shortly after the curve was laid, corrugations or batterings were very pronounced, and careful measurements as to their positions, depths and pitches were recorded. After a time the curve was taken up and relaid with new rails of an exactly similar pattern, and make, to those first adopted. After some wear batterings or corrugations appeared again at the same identical spots, and to the same depths and pitches.

The following sketch shows, in diagrammatic form, the



waviness of the corrugations which appeared in both sets of rails laid for experiment.

Drillings were taken from the crest of one of the rails at points "A" and "B" with a view to finding out whether or not there were any chemical changes in the structure of the metal at the points affected. It was analytically proved, from the drillings, that the chemical compositions were exactly the same in both cases.

Grinding, as you are aware, is much practised to get rid of corrugations as they appear. The writer has no information on the point as to whether rails corrugate more quickly after grinding, than before.

Ordinary steam railways are, it is well known, built up on

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the side-supported principle, by constant packing of the track sleepers by platelayers. On these, as shown in Illustration No. 10, corrugations are very prevalent.

For the purpose of discovery, the writer endeavoured to find out in connection with both steam and electric railways—

(*a*) Whether the pitch of the corrugations (or batterings) varied with the speed of the trains?

(*b*) Whether the corrugations varied in their pitch *in ratio* to the speeds?

(*c*) And whether corrugations (or batterings) were more frequent on curves than otherwise?

The information received on points (*a*) and (*b*) is to the effect that the pitch does vary under different speeds, but no actual results *in ratio* are forthcoming. In regard to point (*c*), corrugations (or batterings) are undoubtedly more frequent on curves than otherwise.

The writer thinks that from the foregoing information, the cause of corrugation has been, for practical purposes, brought down to a minimum. By this, he means that corrugation must form some inherent attachment to all track constructions, which do not possess more or less resilient beds, on the lines of that shown in illustration No. 8, and it rests with some ingenious person to design a track for electric traction on roads which will give both resiliency and stability for tramway traffic, with reasonable maintenance charges, and, at the same time, provide a surface which will satisfactorily sustain, for a reasonable period, the ordinary road traffic.

The writer thinks that the replies received to the questions circulated make it abundantly clear that corrugations are not caused by—

(*a*) Electrolytic action.
(*b*) Rolling stock (*per se*).
(*c*) Driving and braking.
(*d*) Soft rails; or
(*e*) Resilient tracks.

That whatever the real cause may be, it is aggravated by—

(*a*) Impact and vibration.
(*b*) Hard rails.
(*c*) Rigid beds; and
(*d*) Curvature.

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A great deal of the information contained in this communication has already been sent, by the writer, in the shape of a report, to the Tramways Committee of the Institution. It is at the request of the latter that this paper has been prepared, and presented, to-night, with an invitation to those present to express their views in connection with the abstruse problem of the actual cause of rail corrugation.

DISCUSSION.

MR. M. HAINSWORTH: This subject is one of very great interest to all local authorities, and I think the thanks of this meeting are due to Mr. Wakelam for his paper, and also to the Tramway Committee of the Institution for going into the matter. In Teddington we have suffered very considerably from this trouble of rail corrugation, particularly as regards noise. It was alleged that the noise arose from corrugation, and also from defective joints. The Company owning the tramway passing through our district sought to remedy the cause of complaints, and they welded the joints of the rails, ground down the joints to a level surface, and also ground out the corrugations. The result of that was very noticeable. The noise was abated, and although it is twelve or eighteen months since the work was done, there has been no recurrence of the noise. I must admit that the corrugations are now reappearing. May I put forward a suggestion that a crystallisation of the fibre of the steel, owing to the constant vibration, occurs, as in the case of shafting in a mill, and that owing to defective joints the wheels of the cars become irregular in shape, and the impact which results produces this trouble. I have also wondered whether rusting of the surface of the rail has anything to do with the corrugation of the rails.

MR. W. FAIRLEY: I wish to bring some information forward which may be of use to Mr. Wakelam. I have under my direction a small light railway with a gauge of about 3 feet. The rails are 20 lbs., and flat on the top. This little railway is worked by a petrol locomotive. Any one who has anything to do with tractors of this description will know that a great deal depends upon the man who is working the locomotive. The

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tractor in question only weighs about 18 cwts., but easily draws between four and five tons. In starting the tractor it has a certain amount of slip. I found on this railway that corrugation was formed on the rails exactly similar to those formed on the tramway systems of this country, the corrugation running at right angles to the face of the rail. Considering the matter, I came to the conclusion that the corrugation arose from slip when the locomotive was starting. The part where the rails were affected was straight, and the speed was low. When the locomotive is starting the trucks it goes forward, hunting, viz. pulling on the springs. After each pull it has to go back a short distance, and if the wheels are rotating it must set up wear on the rail. This only gives an instance of corrugation of rails on a tramway, which is not an ordinary tramway, and worked neither by steam nor electricity, but develops yet exactly the same appearance on the rails as an ordinary street tramway. Might I suggest that, after all, slipping has something to do with the matter. If any one goes down to St. James Park station, and watches the district trains, for preference going to the end of a train when it is starting, they will see that the motor in the rear car evidently develops greater power than can be utilised, and consequently slips. When the train is started the rear car hunts, that is, pushes in a series of waves up against the train. In that case, you can see that the wheels are revolving at a much higher rate than the train is going at. In the case of tramcars driven by geared motors on the bogies, each of these bogies has a certain amount of play. The amount of play may be small, and I suggest that the possible reason for corrugation may be the motor pushing on the springs, so to speak, forward and backward a little bit, and causing a grinding motion on the rail. Once you get one spot on the rail you soon get another. In the suburbs we have had some interesting experiences recently of the effect of motor 'buses on macadam roads. If you take a macadam road which has had a fair amount of wear from motor 'bus traffic for some time, and examine it, you will see the road is corrugated, only the corrugation is much more pronounced than those shown on the surface of the rails illustrated. I believe this arises first from a small indentation or pot in the road. I think the Institution is greatly obliged to Mr. Wakelam for the immense amount of labour he has undertaken in tabulating all these returns. I admire the extreme honesty of the paper. It

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tells us, there are all the returns, and the returns are so contradictory that you cannot make much of them. I have put forward the facts relating to a light motor working on a tramway, as it possibly may give some clue to the cause of the corrugation mentioned in the paper.

MR. W. J. HADFIELD: As the engineer responsible for the construction and upkeep of the Sheffield tramway system, I have had a great deal of trouble through corrugation. The thanks of everybody are due to Mr. Wakelam. To make a compilation of all the reports which have been received and to endeavour to deduce from them some conclusions as to the causes of rail corrugation must have been an enormous task. Mr. Wakelam, having set out the various reasons assigned for corrugation, says, "It may be argued that the trouble is chiefly set up by combined influences, such as (*a*) the constant oscillatory motion of the car wheels on the rail surface, due (1) to high speeds; (2) to bogie cars; (3) to short wheel bases; and (4) to heavy car platforms." We have a fair amount of corrugation in Sheffield, but we have never had a bogie car there, so that may be dismissed as a cause of corrugation. Mr. Wakelam points out that cable tracks suffered from corrugation to a limited extent only, and says the trouble in this connection was always attributed to braking. I do not know whether others here (like myself) have seen the cable route between Handsworth and Birmingham. The cause of its corrugation was carefully investigated by a Committee of the Municipal Tramways Association, whose report showed that in this particular case there was a critical speed, and that when the cars exceeded 7 miles per hour corrugation followed. The Committee were informed "that the cars on that portion of the tramway inside the City (Birmingham) were formerly run at a speed of 7 miles per hour, and no corrugation appeared, while on the portion of the system outside the City the cars were run at a speed of 9 miles per hour, and extensive corrugation developed. The speed of the cars running on the inside section was subsequently increased to 9 miles per hour, and then corrugation became general on that section, showing that the critical speed on this system was between 7 and 9 miles per hour. This is very important as showing that speed is a cause of corrugation. The wheels of the cars were 24 inches in diameter." The critical speed in this case was between 7 miles and 9 miles. I may also say

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in Sheffield we have carefully investigated whether corrugation could be traced to braking (another possible cause mentioned by Mr. Wakelam), and we have come to the conclusion that braking has nothing to do with it. Mr. Wakelam says that vibration may also have some bearing on the question. That ought to be followed up very carefully if anybody can get an instrument with which to follow it up. One of the Members of the Municipal Tramways Association Committee has shown that there are 18 separate and distinct sets of movement during the passage of a tramway car over the rails. This is surely well worth investigation. A word as to the rails. In Sheffield we adopted one of the British standard sections, but found it was unsuitable, the web having a tendency to split, and if the web of a rail is weak enough to split it will be weak enough to vibrate. In Liverpool, Leeds, and Sheffield, the Tramways Authorities have adopted a heavier rail, and have strengthened the web. We are using now in Sheffield a rail weighing 120 lbs. to the yard, 10 lbs. heavier than the heaviest British standard section. I see Mr. Wakelam says the Engineers at Accrington, Ashton-under-Lyne, Heywood, and West Bromwich have replied stating that the tramways there are not at all affected by corrugation. I would certainly like to ask those towns in what way their method of laying the tramways differs from that in other places. If the differences are analysed closely we ought to be able to get at the reasons for absence of corrugation. We ought to inquire, for instance, if in those towns the joints are welded. I think with Mr. Hainsworth that the welding of the joints has something to do with it. The comparison between the various tube railways is instructive, one track has elasticity, and the other is rigid, and they get different results with regard to corrugation. There is a reference in Mr. Wakelam's paper to the chemical composition of the rails, but there is no reference to alterations in the structure. In Sheffield we have gone into the latter question. We have had pieces of corrugated rail cut out, and etched in acid. We have planed the corrugation off, placed the piece in acid, and got most useful results in that way. Where the corrugation has occurred the surface structure is in waves, these running in and out from the gauge edge, just where the corrugation had been. If we can get a rail strong enough to resist the action which causes this alteration in structure we shall not have corrugation.

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Mr. W. Harpur: I take the opportunity of formally moving a vote of thanks to Mr. Wakelam for the very excellent paper he has given us. I consider it a most valuable paper, and I think he is entitled to something more than an ordinary vote of thanks for the immense amount of work, not only in writing the paper, but in tabulating the replies which have been received to the voluminous inquiries made by the Tramways Committee. It does not solve the difficulty, but still it gives us any amount of room for thought and experiment, and for endeavouring to try further what can be found out in reference to this vexed question. Mr. Hainsworth said something in reference to grinding out corrugation. I should like to say what my own experience has been in regard to that. I was very proud for a time in finding we had no corrugation on our tram rails in Cardiff for the first three or four years after construction. I was constantly being asked by tramway engineers about corrugations. I said, "We don't know what they are." But they started, and once they commenced they came on very quickly, hammered joints as well as corrugations. We commenced by taking up a few of the rails which had most corrugations, but this was too costly a matter, as corrugations were increasing so rapidly, and so we tried rail grinding, and succeeded, as Mr. Hainsworth said they did at Teddington. Since then we have followed that practice regularly. As soon as we find corrugations beginning to occur on any section of the track we get it ground out, and in that way we keep the thing down to a minimum. Up to the present it is the only solution we have been able to find. The trouble is not confined to where there are loose rails only, but where they are tight on the bed they corrugate also. That makes one wonder whether or not the rigid bed is the best. It is a most troublesome thing to come to a conclusion on the matter. I must say I rather fancy the rigid bed has a great deal to do with corrugation. Naturally, if you have got two hard substances one hammering upon the other, it has a bad effect upon the rails, and also more or less upon the wheels. Mr. Wakelam does not say anything in his paper as to whether he has heard of corrugations upon the trolley wires. I do not know whether any one else has, but I am told that corrugations do appear on the trolley wires, the same as on the rails. If that is a fact it shows that neither a rigid bed nor an elastic bed has anything to do with the question. That is a point I should like, if we

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can, to find out something about. The question of the rails is the only thing we have to deal with in our Institution, we have nothing to do with trolley wires, and we have no occasion to find out about corrugation of those wires. We must try and find out that information from another source. Mr. Fairley mentioned the question of slip as having something to do with it. I think there must be a great deal in what Mr. Fairley says upon that point. My experience is that slipping is not at the starting and stopping of the motor. I find, where we have a compulsory stopping place, for some little distance before the cars reach the stopping place we get no corrugation, but in between where the cars attain their maximum speed the rails corrugate. We find that the corrugation occurs where they have an optional stopping place, that is, where cars simply pull up when they are required to, but many of the cars run over those places. At compulsory stopping places we find no corrugation for some distance on either side. That convinces me it is the speed which has, I will not say everything, but mainly, to do with corrugation. That seems to be largely borne out by what Mr. Hadfield has told us about cable trams at Birmingham. Where the speed was seven miles an hour they had no corrugation, where the speed was nine miles corrugation appeared. My experience at other places seems to confirm that up to the hilt. But I am afraid that is not the experience of some other people. I do not know where to drop upon it in Mr. Wakelam's paper, but I think he tells us that corrugations appear at stopping places. So even there we are not all of one mind. There is still a difference of opinion upon that point. There is a statement I would like Mr. Wakelam to explain a little further. "That in connection with a car travelling at a speed of twelve miles an hour the wave was noticeable on the rail head at a distance of 240 yards from the car. That at a distance of 160 yards vibration was general. That at a distance of 70 yards vibration was distinctly accentuated as the car passed over each joint, and that vibration was not so pronounced on the curves as on the straight track." Does he mean to say he can see the corrugation at a distance of 240 yards? Then Mr. Wakelam says that "tracks used by bogie cars are more corrugated than those confined to cars with fixed frames. This may be due to the oscillation caused by the small wheels of the former." I think there is something in that, and to the fact that they are

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more or less loose, not so firmly connected as with the fixed truck cars. In the cases given in the paper in which no corrugation has appeared, I would like to ask how long the rails have been laid and the frequency of the service of cars upon those tracks, because those are points which have a great deal to do with it. Further, I would like Mr. Wakelam, if he can, to ascertain the speed at which cars run over those lines. In summing up Mr. Wakelam says, "The writer thinks that from the foregoing information the cause of corrugation has been, for practical purposes, brought down to what may be termed a reducible minimum. By this he means that corrugation must form some inherent attachment to all track constructions which do not possess more or less resilient beds, on the lines of that shown in illustration No. 8, and it rests with some ingenious person to design a track for electric traction on roads which will give both resiliency and stability for tramway traffic with reasonable maintenance charges, and at the same time provide a surface which will satisfactorily sustain for a reasonable period the ordinary road traffic." I quite agree with Mr. Wakelam that this is just the thing that is wanted. That is, a certain amount of resiliency with stability, but the difficulty is, how are you going to get that on the ordinary road? If you have a resilient tram track, that means it must pull your paving to pieces, the paving must go with the rail or it is impossible to have a resilient track. I quite agree with what Mr. Wakelam says, but I am afraid, if that which he suggests is to be attained, it must mean that tram tracks must be taken off the streets and put elsewhere, either on a separate piece of road or where the road traffic is not to run as well as the tram lines. I hope that this paper at any rate may have the effect of putting those who have tracks under their care upon further investigation, and that we shall find some solution for this troublesome problem. It is a troublesome problem, because a corrugation of the rails does not only mean corrugation, but it means terrible noises upsetting the nerves of people who live upon the roads, and it also means that you cannot keep the paving of the track in decent order, everything adjoining the rails is shaken; one thing follows the other; and unless we can find some solution we shall be constantly troubled as we are at the present time. Mr. Fairley spoke about the corrugation of road surfaces. I quite agree with Mr. Fairley. It tends to show that you not only have

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rails which corrugate with high-speed traffic, but you get your corrugated roads, unless you have a surface which cannot be corrugated, and I do not know that we have got that yet. As far as I can see, speed has more to do with corrugation than anything else, but at the same time we cannot suggest the reducing of speeds. The tendency is to increase speeds everywhere. For that reason we must try to find some other solution.

MR. R. B. HOLT, Leeds: I desire to express my appreciation of the efforts of Mr. Wakelam to solve this elusive problem of rail corrugation, single handed. I have spent many years on the problem, both personally and as a member of the committee appointed by the Municipal Tramways Association, and I realise fully what an onerous work it is, and I think that Mr. Wakelam must have discovered that the task of Hercules to clean out the Augean stables was mere child's play compared with this. Mr. Wakelam, no doubt, found that nothing of a reliable and satisfactory nature could be obtained from the replies to queries. I have generally found such replies to be erroneous and misleading, they generally record impressions, not facts, and it has been found possible to obtain quite different information on personal investigation. Mr. Wakelam's experiments in regard to rail vibrations are interesting, and I should like to have further information as to the type of recording instrument used, and perhaps Mr. Wakelam would inform me whether the results obtained were constant for different tracks and different cars at the same speeds. Reference is made to the absence of corrugations on some tracks, and on others the trouble is said to increase in ratio with the traffic; personally I have found no system which is entirely free from corrugations in one form or another, though some of these tracks suffer little or nothing from its presence. Many places have corrugation markings, very pronounced in appearance; but these do not develop. The rails which have suffered most on the tracks which I am responsible for, are those of British Standard quality, Basic Bessemer steel. The earlier rails with low carbon content, but with a high percentage of manganese, gave better results, and the best results have been obtained from the use of Sandberg steel rails (Basic Bessemer), with high percentages of carbon, silicon, and manganese. These latter rails are by no means immune from corrugation markings; but after five years'

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service in all positions, it has not been found necessary to grind out corrugations on rails of this quality. I should like to state that the appearance of pronounced corrugation markings (*i.e.* bright patches or bars across the rail tread) is not dependent upon the number of cars which have passed over the rail at that place. I have frequently seen markings of this description after the passage of one car, which have been obliterated by successive cars. As will be seen in the interim report of the Corrugation Committee of the Municipal Tramways Association, artificial corrugation has been producd on rails by means of white oil paint fed through pads pressed lightly against the wheel tyres; but it was impossible to produce these indications at will, nor was it possible to obtain the same result again at exactly the same place. From this it would appear that the corrugative influence is without the rail. I find that corrugation is just as prevalent on tracks operated by single truck cars. In Leeds we have no other type and we have suffered to a considerable extent. I am pleased to note that Mr. Wakelam does not consider that rails possess any inherent tendency to corrugate; this has long been my conviction, but some rails are undoubtedly more prone to the destructive reaction than others. I cannot support Mr. Wakelam in his finding, to the effect that hard rails and rigid beds aggravate the "cause of" corrugations, neither do I see his reason for assuming that the rolling stock and resilient tracks are not the cause of corrugation. I have not found any rational connection between speed and the pitch of corrugations; but it is apparent that, under normal conditions, there is a critical speed somewhere between 7 and 12 miles per hour, above or below which corrugations do not appear to any great extent. I do not think that Mr. Wakelam can really be of the opinion that "flats" on wheels have the remotest bearing on the subject. Flats may only occur once or so on a wheel eight feet or more in circumference, and frequently long stretches of corrugation appear at one time, in addition to which the vibration periodicity necessary to produce corrugations of 2½-inch pitch would vary between 63·36 impulses per second, at 9 miles per hour, and 105·12 per second at 15 miles per hour. It may be of interest to this assembly to know that the Corrugation Committee of the Municipal Tramways Association, as the result of a number of experiments carried out in different places with a differential

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recording apparatus, which recorded the relative difference between the distance travelled, and the distance represented by the revolutions of the wheels, together with the slip and skid which took place, and also by means of hardened steel studs inserted in the wheels of a car, discovered that slip and skid are continually taking place, and that a purely rolling motion seldom takes place. From this and numerous other experiments extending over a considerable period it was deduced that the slip and skid referred to take place owing to the different diameters of the wheels which is prevalent, and which is largely the result of the unequal wear produced by the relative difference in the speed of the two motors. We think that the slip or skid referred to, which results in attrition, may be responsible for the formation of the hollows, and that a purely rolling action combined with increased pressure or hammering action may account for the brightness of the crests. This combined with synchronous vibrations between rails and wheels appears to me to afford an excellent field for the closest investigations; indeed, I am sure it is the threshold of the door leading to solution.

Mr. Benedict: When I was Secretary of the Tramways and Light Railways Association, I tried very hard to get the different interested societies to work together with reference to this subject of rail corrugation, but I did not succeed in my object. My successor, however, has succeeded, and the Tramways and Light Railways Association has co-operated with the Municipal Tramways Association in preparing the recently issued interim report, which is very interesting. It appears to me that the Institution of Municipal and County Engineers has been working in a lonely furrow. The paper shows an enormous amount of industry, but the same kind of thing has been done before, and it seems to me to be an overlapping and a waste of labour. There is no reason why foreign Institutions should not work with our Institutions, and if that could be brought about I am sure we should have a better chance of getting to the root of this matter. There is one suggestion which has been made by Mr. Worby Beaumont to which allusion has not been made this evening, and which to my mind is the only theory which accounts for ridges or corrugations being bright and the hollows dull. If the scooping out of the hollows is due to friction surely they ought to be bright, but the theory

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is that, under certain conditions and with certain qualities of rail, cold rolling results in corrugation. In other instances it results in the spreading of the rail, and when the rail is very hard in fitting. If the rail is of such quality as to allow rolling and hammering to affect it, then it will be rolled out until the ridge is jumped over, and then the ridge is bright. That seems to me to be very near the right thing. Mr. Beaumont's contention is that corrugations do not appear so often on railways because the wheels are larger, and the weight per rail is less intense and spread over a greater surface. When you come to small wheels the stress is much more intense and these corrugations appear. It seems to me this is a very sensible theory which might be further investigated.

MR. J. L. REDFERN: I have noticed corrugations appear in road surfaces soon after they are formed; and this happened not only on roads subject to 'bus traffic, but also on other roads. I have had an impression it is due to road rolling. I have not followed the question up, but there seems to me to be something in it. Whether it is due to the slipping of the wheels or the rucking, which takes place as the roller proceeds, I cannot say, but I believe it is caused during the making of the road, and affected by the degree of traffic afterwards.

MR. W. HARPUR: I know a certain railway in South Wales where the traffic is light. It consists largely of little motor trains, running backward and forward, and that railway is badly corrugated. You cannot go far without seeing corrugations on the rails. I put it down to the light rolling stock. On the main lines with heavy coal traffic we do not find corrugation, but on this little passenger line with light locomotives there you find corrugation.

MR. HOLT: Mr. Beaumont's theory is not the transference of the metal, but the section of the metal is scratched to such a point that there is permanent distortion. The etchings we have made show a different result. I had some special tests made by Mr. Carpenter at Manchester University, and he said that the rail was amorphous. The fact that the pieces of rail sent for testing were amorphous, shows that hammering did take place at that point.

MR. J. W. COCKRILL: I have much pleasure in seconding the vote of thanks to Mr. Wakelam. So far as tramway tracks are concerned I have constructed 14 miles at Yarmouth. On

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the first portion of 6 miles we had no corrugations for some years. Then corrugations began to appear, but we left them alone, and after a time they disappeared, but after about eighteen months they reappeared again, and then we started to grind the corrugations out. We then found the rails went about two years, and it seems likely that every two years we shall have to grind out 14 miles of track.

The President: You have heard the proposal of Mr. Harpur, which has been seconded by Mr. Cockrill, that we accord a hearty vote of thanks to Mr. Wakelam for his interesting paper. So far as I am personally concerned I am in the fortunate position of having practically no tramways to look after. We have something worse, and that is corrugation on roads, and it takes us all our time to eliminate these. If there are these corrugations in steel, how much more must they be in macadam roads.

The vote of thanks having been unanimously accorded,

Mr. H. T. Wakelam, in reply: I am very much obliged to you for the vote of thanks. It has been a great pleasure to undertake the task of tabulating these returns and preparing the paper, though one found a difficulty in forming any decision as to what was the cause of corrugation from the replies to the seventy-seven questions which were formulated and circulated. There have been very many experiments carried out to find out the cause; there have been acid tests, driving tests, and all manner of other tests, and nobody seems to have come to a conclusion as to what was the cause of the trouble. Mr. Benedict referred to an opinion of Mr. Worby Beaumont as to cold rolling and cold flowing having something to do with the cause of the trouble. Mr. Holt has replied to that, and has said that Professor Carpenter of the University of Manchester has carried out a great number of microscopic experiments in connection with that point, and I believe that his results do not quite coincide with the results or opinions that had been put forward by Mr. Worby Beaumont. Mr. Benedict also referred to the work of tabulation, and he was good enough to say that he hoped the tabulations would be published by the papers of which we have representatives here to-night, but I do not understand why the replies should be published, especially as Mr. Benedict stated that the work had already been carried out by other Institutions, and they already had the information. I am sorry that we did

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not know that other Institutions had got it, because it would have saved me, and the Tramway Committee, and our Secretary a great amount of trouble. We are glad to hear that Mr. Benedict was in a position to give us that information, because from the replies to this Institution, and the replies which have been given to the other Institution, we may benefit and jointly come nearer to a solution of the trouble. I think it was Mr. Harpur who raised a point as to corrugation in connection with trolley wires. Mr. Fairley referred to "slip" being a cause of corrugation. I do not think those two theories can go together, because there is very little slip in connection with the trolley wire. I do not think it is slip which is the cause of the trouble. The theory has been put forward that expansion and contraction of the rail head is the cause of corrugation. Engineers who have tramway rails laid are very careful to see that the analyses of the composition of the rails are complied with. If those analyses are complied with, I do not see why one part of the rail should expand and contract, and the other part remain in the normal state. I do not think that expansion and contraction is the cause for that reason. Rails which are of the same construction microscopically and otherwise suffer in different degrees in different parts of the track. Therefore it cannot be cold rolling or cold flowing or anything of that kind which causes a rail to corrugate for 20 or 30 yards, and then remain good for 2 miles. A point put forward by another Institution similar to our own is that a greater amount of resistance in the rail might cure the trouble. We find a rail having 0·6 of carbon is difficult to handle, and if you get a greater amount of carbon than 0·6, I do not know what is going to happen to the rail, because you are going to have a lot of breakages. Mr. Harpur is good enough to remind me not only in the handling but the bending of the rail. The Sandberg rail has proved itself as receptive of corrugation as the ordinary carbonised rail. There have been a large number of tests carried out, but it appears to me that the whole thing has got into that state which resolves itself into one thing —and that is that all the information which has been obtained on the subject should be sent to Professor Glazebrook at the National Physical Laboratory at Teddington, where he can carry out comprehensive tests and researches, and let us know what is the cause of the trouble which people do not appear to be able to solve. I know, and confess, that the paper which I

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have laid before you is not the last word on corrugation. Perhaps I might almost say that I am nearly as ignorant of the cause of corrugation now as when I went into the tabulation of these replies and the preparation of this paper. A friend of mine who assisted me with tests with two pieces of steel, and had two planed surfaces moving regularly backwards and forwards over each other, found after a time there was corrugation. There was no slipping in connection with that, nor rotary motion, but still there was corrugation. That is another point on which Prof. Glazebrook might throw some light. Mr. Hadfield says the questions were not circulated to Sheffield, Leeds, Manchester, and Glasgow. I am very sorry if they were not sent, because we might have had very useful information from those towns. Then as to the rigid bed. There is no doubt that the rigid bed has a great deal to do with corrugation. When you take into consideration the conditions on the underground railways of London, undoubtedly there is a good deal to be said on that point, and resiliency would do a great deal to alleviate if not to rid us entirely of the trouble. Mr. Harpur wanted me to explain the distances referred to in the paper as to vibration waves. The vibration wave referred to was noticeable at a distance of 240 yards from the car. The distance was measured by a tape measure on the road, and it was signalled when a car got to a certain spot. The instrument was put on at that point, and the greatest distance at which vibration was noticeable was 240 yards. I have no evidence as to the ratio of the wave in relation to the speed of the cars. That applies also to the 160 yards, the 70 yards, and also to the vibration on the curves. Mr. Harpur also in his remarks called attention to the fact that speed might be a factor, if not the cause, of corrugation. The paper states that the corrugations were more defined and noticeable where speeds were low on the curves than on the straight tracks, so it cannot be speed which is the cause of the trouble. Then Mr. Holt was good enough to refer to the pitches of corrugations. I am sorry I did not bring it with me, but I had a diagram prepared to show that you can get corrugations at any pitch with different speeds. You can get them from a 1-inch pitch upwards. I am sorry I did not bring that diagram, because it would have interested Mr. Holt. I have only to say as to corrugations appearing and disappearing that that is a curious thing. It has been mentioned in the case of Sunderland, where

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they experienced the same phenomena in connection with the subject. If corrugations appear and disappear, as they have been known to, it seems we are further from the solution than when we started, because we must find out the cause of the appearance and the cause of the disappearance. I should like to say in conclusion that money will be absolutely wasted if isolated experiments are carried on; but with regard to the tabulation, a good deal of money can be saved if the information therein contained could be sent to Dr. Glazebrook and let him go into the whole question. Whether it is a national question I do not know, but to tramway companies and to Corporations who are interested in the upkeep of tramways, and who have to spend 6000*l.* a year as they do in Leeds, I should say that money spent in connection with researches by Dr. Glazebrook would be very well spent.

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SOUTH WALES DISTRICT. MEETING AT SWANSEA.

January 11, 1913.

Held in the Guildhall, Swansea.

R. J. THOMAS, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Members were received by the Mayor (Mr. D. Williams), who offered them a very hearty welcome to Swansea.

The President thanked the Mayor for his kind welcome to the town. He stated that the Members of the Institution were naturally much interested in the development of the town planning scheme, and he congratulated the authorities on the undertaking they had set on foot.

The following were elected as the Executive Committee: Messrs. H. Tremelling, G. Bell, D. M. Jenkins, W. L. Harpur, A. J. Oborn, J. C. Pardoe, W. J. Jones, Members, and D. L. Jones, I. F. Shellard, and C. H. Bell, Associate Members.

The following papers were discussed.

SWANSEA TRAMWAYS, PAST, PRESENT, AND FUTURE.

BY GEO. SWARBRICK (*Member*), DEPUTY BOROUGH SURVEYOR, SWANSEA.

SINCE July, 1905, when Mr. George Bell, the Borough Surveyor, submitted a paper to the Institution of Municipal and County Engineers on "Some Municipal Works in Swansea," there has

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not been very much tramway work actually carried out in Swansea, but a great deal has, however, been done on paper. Such work as has been completed may present some points of interest generally to the members and provoke interesting discussion.

It should first be stated that last year the Corporation and the Tramway Company came to terms in regard to a new lease of the lines, constructed by the company under their Acts of Parliament, dated 1874, 1878, 1879, and 1882, which, by section 43 of the Tramways Act of 1870, the Corporation would not have been able to possess finally until a very remote time at the end of the century. The Borough Surveyor made an exhaustive report on the subject and arrived at an average term of $24\frac{1}{4}$ years in respect of a new lease of the whole mileage of the company's lines, and the lines subsequently constructed by the Corporation and stated that "An average term of this number of years in respect of the whole mileage of the tramways would be equivalent in value to the collective value of the varying terms of the different sections under the existing conditions."

Mr. MacElroy, the General Manager of the Manchester Tramways, was then called in as specialist to advise, and eventually an agreement was entered into between the Corporation and the Tramway Company for a lease of 30 years of the whole undertaking on terms and conditions which were considered mutually satisfactory and equitable. The ground being thus cleared arrangements could then be made for certain extensions which were very much needed, and which by the terms of the new lease would be worked by the Tramway Company. Previous to this, in 1908, the tramway in High Street having got into a very bad state of repair, and the Corporation being anxious to improve the sides of the roadway, arrangements were made between the Corporation and the Company, whereby the tramway from College Street to Prince of Wales Road was reconstructed and doubled, with new material, and the whole width of the roadway, including the tramway track, laid with soft wood paving. The rails were 95 lbs. to the yard from Belgium, laid on creosoted pine sleepers, 8 feet by 9 inches by $4\frac{1}{2}$ inches deep, placed 3 feet apart, centre to centre. The rails were jointed by fish plates weighing $49\frac{1}{2}$ lbs. per pair, having six 4-inch Ibbotson's bolts and nuts to each pair. The rails were attached to each sleeper by means of four $\frac{3}{4}$-inch diameter coach screws, 6 inches in length. Sole plates 24 inches long, 10 inches wide and $\frac{5}{8}$-inch thick were

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placed under each joint between the rails and the sleepers. Concrete 6 to 1 was laid from 9 inches to 6 inches deep under the level of the rails and upon which the floating and paving were laid. Cranked tie-bars 2 inches by ⅜ inch placed 6 feet apart. The points and crossings were made of Allen's "Imperial" patent manganese steel, the former in pairs, consisting of two points, and 10 feet 9 inches long over all, each point having a movable tongue, thereby doing away with the dummy point, and providing smoother running for the cars.

The first work undertaken by the Corporation and the Tramway Company after the agreement, was the reconstruction and doubling of part of the line from Swansea to Morriston, a length of 6 furlongs 2·25 chains, and paving the track with granite setts. At the same time the Corporation widened the roadway to 60 feet, and also laid down granite sett paving for the full width of the road. The method of laying the track and materials used was similar to that in High Street.

Following on the agreement between the Corporation and the Company, Parliamentary powers were obtained last year for laying tramways in Castle Street (now widened to 60 feet), Temple Street, Castle Bailey Street, Mount Street, Oxford Street, Wern Fawr Road, and Carmarthen Road, and the tender of Messrs. W. Griffiths & Co., of London, has been accepted for carrying out a portion of this work, viz. Castle Street, Castle Bailey Street, Temple Street, Oxford Street, and Mount Street. The remainder of the lines, viz. Wern Fawr Road and Carmarthen Road, will be commenced as soon as negotiations for the purchase of properties for road widenings have been completed.

The present mileage of the tramways, reduced to single line, is as follows:—Company lines, equal 8·58 miles; Corporation lines, equal 10·33 miles; the above extensions, 1·56 mile. Total when completed, 20·47 miles. The Parliamentary plans and detail drawings of these works are open for the inspection of the members.

Mainly for the development of the valuable estate possessed by the burgesses on Town Hill, it has long been contemplated to construct a tramway up Mount Pleasant, Terrace Road, and Penygraig Road, and the Borough Surveyor prepared reports and schemes for the same. The construction of this tramway has now become urgent, owing to the acquisition by the Corporation of 107½ acres more land on Town Hill by purchase, for the sum

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of 19,250*l.*, from the Duke of Beaufort and the Garden Suburb Freehold Co. In their determination to develop the same as soon as possible the Corporation have thus become freeholders of the whole of the Hill.

A development scheme, on Town Planning lines, has been prepared for the Corporation by Mr. Raymond Unwin, F.R.I.B.A., in conjunction with the Borough Surveyor, which provides space for about 1400 houses on the southern slope of the hill alone. This plan is submitted for the inspection of the members as an excellent example of Town Planning in an extremely difficult place.

A report has just been obtained by the Corporation from Mr. Stephen Sellon, M.Inst.C.E., on the best method of dealing with the problem of tramway communication between the town proper and Town Hill.

The total length of the Mount Pleasant and Penygraig Road route is 4580 feet (0·867 of a mile), and the total rise is 466·56 feet, which gives an average gradient of 1 in 9·82. The steepest gradient on Penygraig Road is 1 in 5·56 feet for the length of 140 feet, and that on Terrace Road is 1 in 7·78 for a length of 125 feet, and on Mount Pleasant 1 in 7·3 for a length of 140 feet. The lengths of roadway which have gradients steeper than 1 in 8 total up to 1440 feet.

With such severe gradients it appeared that the only practicable method of working a tramway would be by means of cable, and that working by electricity in the ordinary manner was out of the question. However, Mr. Sellon, in his admirable report, advises that a tramway can be safely worked by ordinary overhead electric traction, by reducing the ruling gradient of 1 in 5½ referred to by means of cutting and filling to 1 in 8. If these recommendations are adopted a double line 4 feet 8½ inches gauge would be laid throughout, and the roadway widened to 40 feet. Mr. Sellon's scheme embraces the construction of a tramway on the northern slope of the hill north-east, to the works district at Cwmbwrla, and a tramway along Town Hill Road south-west, to the residential district of Sketty. These tramways, being of the same gauge, would give means of intercommunication between the town and the magnificent future dwelling area of Town Hill, and also the works districts, being connected to the existing tramways in Grove Place, Carmarthen Road, and at Sketty.

One of the conditions of the Local Government Board in

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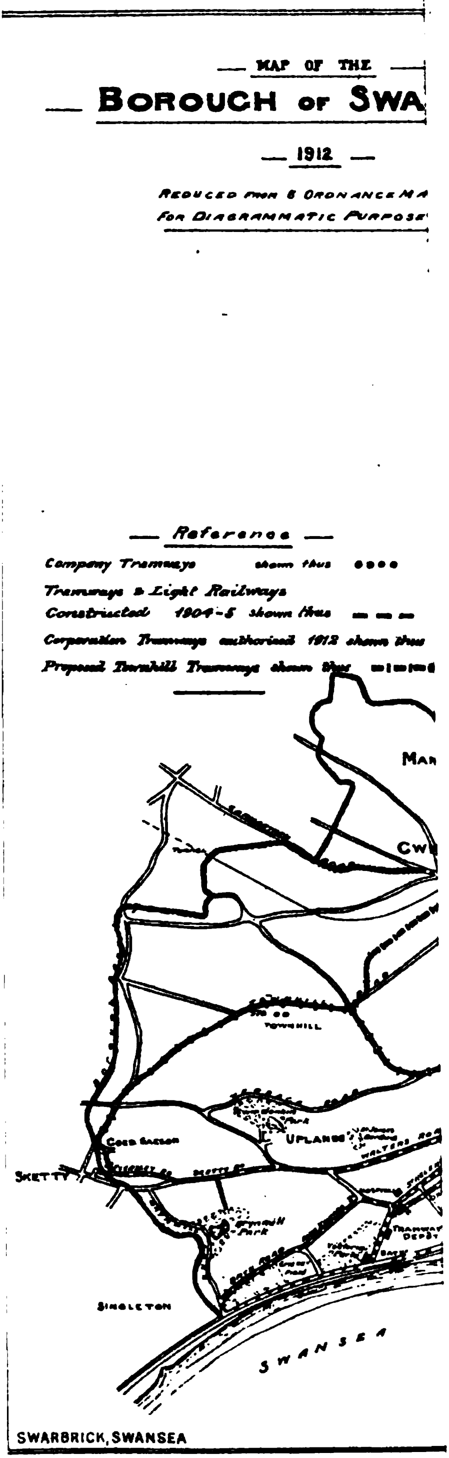

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giving sanction for the purchase of the Duke of Beaufort's land on Town Hill is that the Corporation should agree to build, within a stated time, 300 houses for the working classes on the land, and this they have undertaken to do; so within a very few years we may look forward to not only these houses, but a large number of houses for all classes of the community, and a network of up-to-date tramways giving access to every part of the borough.

The work in connection with the Corporation Tramways constructed in 1904, and the extensions herein referred to was designed and carried out under the direction of Mr. George Bell, A.M.I.C.E., the writer being his chief assistant in the matter. Mr. Dd. James, the General Manager of the Swansea Improvement and Tramway Company, represented the Company throughout, Mr. Ed. Fitzmaurice, of London, being their engineer who collaborated with Mr. Bell in devising the details of the work and superintending the same.

Messrs. Wm. Griffiths & Co., of London, were the contractors for the High Street and Neath Road improvement, and they were represented by Mr. B. Griffin, A.M.I.C.E.

The accompanying diagram shows the existing, intended, and proposed future tramways.

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THE DEVELOPMENT OF THE PENTRE VALLEY IN RELATION TO THE DESTRUCTOR.

By G. H. BELL (*Assoc. Member*),
Assistant Borough Surveyor, Swansea.

There were several considerations that led to the choice of this subject, and not the least important, because of our modern town-planning manner of viewing changes in the character of towns, was that of the evolution of the Pentre Valley from its primitive and probably pleasant state of bygone years, through a period of pronounced unattractiveness, to the more cheerful condition which we may hope it will again assume in a few years more. The other considerations arose from the fact that within the valley, and constituting active and essential factors in its development, there have been, and are still, several civic activities which are of interest to municipal engineers and surveyors.

From a configuration or scenic point of view the valley has no interest. It is small and insignificant, being only some 600 yards in length, and the greatest depth of that portion with which we are dealing is not more than about 40 feet. It is situated in the heart of industrial Swansea, and therefore importance should attach to its future. Notwithstanding its ugliness, which, on a dull day, is particularly felt, the little valley has been chosen by the Housing Committee of the Swansea Corporation as one of their sites for dwellings for the workers.

So far as homes are concerned, the place affords none of the amenities which we try to couple with other factors in determining the choice of position for residences. It has no upland breezes, no view, no foliage; in fact, at present no pleasantness or characteristic operative towards enjoyment. It is not, however, devoid of qualities favourable to the purpose of municipal housing.

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Proximity to the places where the dwellers will work is a great advantage. It remains for the Housing Committee to so influence the further development of the valley that there shall be united with this advantage artificial amenities such as may be created by the provision of vegetation. The sides of the valley rise somewhat steeply from the Cwm Road, which, since the disappearance of the stream, occupies outwardly the bottom position. The course is serpentine, with a general bearing N.W. and S.E.

At the time when the industrial evolution commenced, the stream, called the Burlais Brook, of about 10 or 12 feet in width, ran somewhat parallel with, and on the west side of, the roadway. On the east side of the road were a few cottages, a woollen factory, and a rope walk; whilst at one point, between road and stream, stood the old Cwm Foundry, which, with the cottages, exists to this day. Had it not been for failure to agree purchase terms between the Corporation and owner, the foundry would have disappeared instead of remaining to obstruct the completion of the culverting of the stream.

At a later date a few villas were built some distance up the eastern slope, and subsequently the closely built small houses were erected surrounding the high levels. A squalid character was then gradually given to the valley, which has clung to it ever since. Development seemed foreign to its nature, notwithstanding the change that went on all round.

The stream had become a receptacle for refuse of all kinds, from pots and pans to mattresses, and besides constituting a very insanitary place, it entailed considerable expense annually in keeping the course free from obstruction and filth. Another aspect of the unfortunate character that the valley had acquired may be realised when it is stated that the Gas Company gave up as hopeless the attempt to maintain the lanterns of the street lamps along the Cwm Road, which were destroyed at nights by stones thrown by the rough element which foregathered upon the adjoining slopes.

This was the state of things when the Corporation were looking, in 1903, for a site for a refuse destructor. Here was a place that afforded centrality for the disposal of refuse, and where the products of combustion could be advantageously disposed of for a number of years. The Borough Surveyor saw the opportunities, and upon his recommendation the site, which

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was corporate property, was adopted for the destructor. The erection took place in 1904 by the Horsfall Company, and is fully described in a paper submitted to the Institution on July 14, 1905, by the Borough Surveyor. The plant has been in continuous work except for the necessary stoppages for cleaning and repairs, and there has never been the slightest nuisance caused either from the cells or the chimney stack since the works have been in operation.

The quantity of refuse dealt with has been fully up to the daily average of 64 tons, and the quantity of clinker produced therefrom has not exceeded expectations, viz. about one-third of the refuse. In order to improve the burning of the refuse, the steaming power of the boiler, and to reduce the repairs of the cells, certain improvements in the plant have been effected this year, which will now be described.

The old transverse flues between every two cells had thin walls, which quickly became burnt through, and the flues themselves did not conduce to good draught. Therefore it was arranged to build solid 36-inch walls in place of these flues, and to leave openings 3 feet 9 inches square, in each new wall, near the clinkering front of the cells. These openings being in line would in effect constitute, in conjunction with the last cell, or that nearest to the boiler, which is now used as a combustion chamber, one continuous new flue. New arches over the cells were put in, and these have the advantage of much stronger abutments and supports. Therefore we have now four cells for burning refuse instead of five, the fifth cell acting as a combustion chamber. The old main flue, to which the transverse flues were connected, serves only as a by-pass flue when the boiler is not in full steam. The effect of the alteration is a much improved draught and higher temperature of the gases at the boiler. The increase of temperature has not been measured, but that it is considerable is indicated by better steaming of the boiler, as proved by actual tests of the running of the electric generating plant, without the use of coal, and by the fact that since the change was made the fire-bars of the coal-fired furnace in the boiler have been so fused as to drop from their bearings. The same amount of refuse, or 60 to 64 tons per 24 hours, is burnt by the four cells as formerly by the five cells, by a larger quantity being fed at each charge. The charging and clinkering is done every half hour instead of every 24 minutes, as before the

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change. Each cell, therefore, is still allowed two hours for the consumption of the increased charge. There has been no change in the number of men engaged in the work, but some modification has been made in their duties.

The destructor has been a distinct advantage to the Corporation not only in getting rid in a sanitary manner of half of the house and trade refuse produced in the borough, but in reducing the haulage of the material, which previously had to be taken to tips about 1½ mile further away than the site of the destructor. The clinker has been utilised in the manner contemplated, in culverting the Burlais Brook, and in building the retaining wall and filling up the ground to form the building site. This work has proved to be a great sanitary improvement, and was carried out much below the estimated cost of 13,880*l*. The clinker made admirable concrete, and the blue brick lining in cement has successfully withstood the acids in the water and the scouring action caused by the high velocity due to such a steep gradient as 1 in 45. The space for tipping the clinker above and alongside the culvert is not yet exhausted, but will not last much longer. A self-acting incline was put in and is now in operation for carrying the clinker to the lower levels and has proved most satisfactory for the purpose. Large quantities of mortar have been made from the clinker and Aberthaw lime, and regularly disposed of or used for Corporation work. This is now sold at a reduced price of 4*s*. per ton, which allows a fair profit.

A committee of the Corporation considered for some time the advisability of laying down machinery for making slabs from the clinker, but eventually permitted the Borough Surveyor to make a start by hand labour. The venture has been very successful and the slabs are satisfactory, both in regard to hardness and strength. The manufacture of paving slabs was commenced in April, 1911, and the quantity made and used to the end of 1912 amounts to 6727 square yards. Two home-made jigging machines are used in making the slabs, and found to be most effective. As the space for manufacturing the slabs is very limited, wrought-iron racks are fixed under cover for stacking the slabs on the flat before removing them from the moulds, and these have been most useful. When the slabs are sufficiently dry they are stacked on end in the yard where they are kept for three months before being sent out for use, which time is found to be quite long enough.

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Building blocks have also been, and are being, made as well as kerb and channel. The paving slabs are made 2 feet 6 inches by 2 feet, 2 feet by 2 feet, and 2 feet by 1 foot 6 inches, all 2½ inches thick. They are faced with concrete ¾-inch thick of Porthgain granite chippings, ¼-inch gauge, and granite dust in the proportion of two of chippings and one of dust to one of cement, the body of the slab being three of clinker to one of cement. They are charged at 2*s.* 9*d.* per square yard, which is sufficient to cover all outgoings and capital charges and leave a reasonable profit. The kerbs, faced as above, are 12 inches by 6 inches by 2 feet 6 inches long, to be laid flat, and charged at 1*s.* 9*d.* each. The channel, 15 inches by 5½ inches by 2 feet 6 inches long, all clinker, is charged at 1*s.* each. Messrs. Johnson's London Portland cement is used at present.

Part of the scheme for culverting the stream was the demolition of ten dilapidated dwellings, and the erection of ten others for the housing of the displaced persons. The new houses were built in 1910 a little to the north of the destructor, from the design of the Borough Surveyor, which provided for the construction of the walls with concrete blocks and of the roofs with concrete *in situ.* The rents of the demolished houses were very low, and consequently a very small and cheap type of dwelling had to be erected as a substitute. The erection was done by contract, and the concrete blocks were made by the contractor from destructor clinker for which he paid 2*s.* 6*d.* per ton. The houses are of two classes, (*a*) consisting of one living-room, scullery, and two bedrooms, which were built for 145*l.* and are let at 4*s.* 6*d.* per week; (*b*) consisting of one living-room, scullery, and one bedroom, having cost 135*l.* and being let at 4*s.* per week. Soon after erection it became apparent that there was a defect due to condensation of moisture on the ceilings of the upper floor, the ceiling being the underside of the flat roof. This trouble was cured by inserting wall ventilators just at the level of the ceilings. There has also been some little trouble from leakage through the roofs, which has necessitated tarring and sanding the upper surface. From an appearance point of view, the blocks cannot be said to be a success, as the walls are dull and heavy looking.

In May of this year a start was made towards the erection of the long terrace of fifty houses, which will occupy the position,

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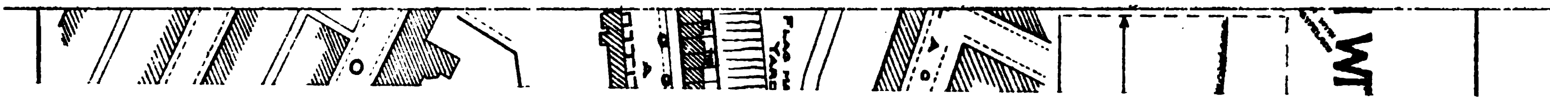

SWANSEA: PENTRE VALLEY, LOOKING SOUTH-EAST, BEFORE CULVERTING
OF BURLAIS BROOK.

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Swansea : Pentre Valley, looking South-East, before Culverting of Burlais Brook.

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Swansea: Pentre Valley, looking South-East, showing Works Completed.

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on the filled ground, over the culvert. Mr. H. C. Portsmouth, of Swansea, is the architect, and the work is being vigorously carried out by the contractors, Messrs. Marles, of Swansea. Already twenty-two houses have been completed, and are occupied. The whole lot have to be completed in twelve months from date of commencement. Such is the great shortage of houses in Swansea that the dwellings have about ten times their number of applicants for tenancy. These houses are also of two classes, viz. (*a*) having kitchen, scullery, and one bedroom, costing 110*l.* each, and being let at 4*s.* per week, and (*b*) having an additional bedroom, being built for 145*l.* each, and let at 5*s.* per week. The walls and roofs are constructed in the ordinary way of bricks and slates. The houses are bright and pleasing in appearance, and will form a valuable part of the large number of houses for the working classes which the Corporation will ultimately possess as the result of the enterprising policy of the Housing Committee. Private enterprise has lamentably failed to keep pace with the rapid growth of population in the borough. Great overcrowding has stimulated the Housing Committee to provide for the shortage of houses, and it is much to their credit to be able to say that, in addition to the 103 houses, inclusive of those now being, and to be, erected at Cwm Road and at Graig Trewyddfa, the Committee intend building another 350 dwellings on Town Hill in the very near future. Surely, never was a local authority made to feel so unmistakably that the provision of houses may be one of their most important functions. Circumstances have, during the last ten years or so, irresistibly called upon the Swansea Corporation for action in this direction, and it has been very interesting to watch the response, and the gradual growth of the function, which has already developed very considerably, and shows promise of being able, in the future, to guarantee that every self-supporting family that comes within the confines of the area over which the Corporation has jurisdiction, shall not only be certain of a house, but one that is up to a proper standard of suitability and obtainable at a reasonable rent. This incidental reference to the housing policy of Swansea need not be looked upon as valueless to members of the Institution. In South Wales the question of housing has been, and will be for years to come, one of great moment, and one in which members no doubt feel much interested.

In conclusion, it may be well to say that the further

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development of the Pentre Valley does not depend upon any complete scheme that has yet been formulated. Its further development has still to be determined.

The Cwm Road, being arterial, and part of the only good route for heavy traffic between the docks and the large Cwmfelin Tin-plate Works and the district beyond, must not be interfered with except by improving and widening it. A good use to which the slope opposite the new houses might be put, after first building a retaining wall and filling up to some extent, would be a children's playground. Having devoted the base of the valley to residential purposes, future action should be in harmony therewith. The slopes at the back of the houses and south of the foundry ought to receive some suitable treatment; the foundry should give way to the completion of the culvert and the filling up of the site; an avenue of trees might be planted along the road; and with a few other minor improvements the place could be given a pleasurable aspect. For years there has been a question of spanning the valley with a bridge so as to link up the districts on each side. The road alongside the destructor is intended for this purpose, and a gap has accordingly been left in the terrace of houses.

In most districts there are places such as this valley that are inconvenient and objectionable. As time goes on it will become more and more the duty of municipal engineers and surveyors to deal with such interesting matters. They must be prime movers in town modelling. Of those members who visit this valley, some may remember from a previous visit, whilst others will be able to imagine, what it was like before the destructor began its changing influence; they will see how altered it is now, hygienically and usefully, how much remains to be done before it can be pleasing to the eye; and they will also be able to indulge in forming a mental picture of the ultimate appearance of the valley. In respect of the latter mental activity it is hoped that the question of further development may form one basis for discussion of this paper, and that some good ideas may emerge.

DISCUSSION.

The President: You have before you two very excellent papers written by members of Mr. Bell's staff. To me personally it is a source of very great gratification to find that our

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younger members are coming forward to supply papers. It is a very healthy sign, and I hope it will be more evident in the future. If all the papers are as concise and excellent as these we shall be very fortunate.

MR. G. BELL: I should like to have the opportunity of supplementing the information given in the paper by Mr. G. H. Bell on the development of the Pentre Valley in relation to the destructor. This information will be very useful for reference in the "Proceedings" at any time when a member of the Institution has a similar problem to deal with. I want to give you the analysis of the Swansea destructor clinker made by Mr. C. A. Selyer, borough analyst, in September, 1909. The figures are as follows: Moisture, 4·50 per cent.; alkalies, 1·90 per cent.; magnesia, 1·50 per cent.; organic and volatile matter, 3·50 per cent.; silica, 51·60 per cent.; aluminium and ferric oxide, 31·20 per cent.; carbonate of lime, 10·30 per cent. The points to be noticed in connection with this analysis are the large proportion of silica, 51·60 per cent., and the very good proportion of lime, nearly 10½ per cent. The effect of the clinker having so large a proportion of carbonate of lime in it makes it very nearly as good as hydraulic lime, and altogether the analysis compares very favourably with puzzolana, which is a natural product, and may be called a natural cement. The acid in the water flowing through the Burlais brook culvert is mainly sulphuric from the washing of tin plates at the works above. I was rather concerned before we started the works as to what effect that acid would have upon the concrete. I took the precaution to put in blue bricks, which have withstood the acid very well, and also the scour of the water in the culvert. With a gradient of 1 in 45, the velocity in the culvert works out at 10 feet per second. That is a very high velocity, but we are fortunate in that the water does not run deeper than 9 inches, so that the volume is not very large. I know from observations I have made that the blue bricks have not scoured at all. The reason for making the culvert so large as 6 feet by 6 feet was to facilitate access to it at any time for observations. When we spread the clinker alongside the new culvert we took the precaution of breaking it up and ramming it thoroughly, and it was periodically flooded with water brought down by a 10-inch pipe. This made the clinker quite hard and perfectly safe to build upon. From observations made we find there has been

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no compression whatever. The steam we supply from the destructor boiler to the generating station has produced as much as 1800 units of electricity for working the tramways for fourteen hours, from eight in the morning until ten at night. The tramways extend over four miles in length, and it is always there as a stand-by whenever they require it. The electric department do not pay anything for this, as they should do. Indeed, they should give us £200 a year. The generating set works up to an average of about 200 horse-power.

MR. W. HARPUR: It gives me great pleasure to move a very hearty vote of thanks to Mr. Swarbrick and Mr. G. H. Bell for their excellent papers. The papers which we have before us are not, to my mind, papers which lend themselves to much criticism. They are papers describing work which has been done, and not controversial. There is one point in Mr. Swarbrick's paper, that is the question of the cross-sleepers in the tramway track, I would like to inquire about. I notice there is a depth of concrete foundation varying from 6 inches to 9 inches. If he has 6 inches under the rail level, that would leave only 1½ inch of concrete under the sleepers. To have only 1½ inch under some of the sleepers seems very little. In laying the tramway track with timber sleepers Mr. Swarbrick has attempted, and I believe he considers he has very largely succeeded, in obtaining a more or less resilient tramway track. That is a kind of track which I think is very greatly needed. If we can have a track of that description it is going to be a success, and up to the present we cannot but say it has been a success in Swansea. The resiliency, I believe, will lead to a reduction, if not the entire elimination, of the trouble we have in some tramway tracks of rail corrugation. I do not know whether any appearance of corrugation has shown itself on any portion of this particular tramway track up to the present. With regard to Mr. Bell's paper, I am sorry that time would not permit of our going up to Town Hill. I am sure the members of this Institution who come from districts other than South Wales do not know the difficulties of town planning in very hilly districts and narrow valleys, and we should have been very much interested in the scheme. I have been to Town Hill myself, and I can assure you it is a district which is a very difficult one to decently plan. I am sure the plan must have given Mr. Bell a very considerable

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amount of work. It is a plan which I hope may appear in the minutes of our Proceedings, because it will be extremely valuable to members of our Institution, particularly in South Wales, where the town planning problems are very serious and very difficult—that is, the planning of hilly districts and narrow valleys. With regard to the destructor scheme and the culverting in connection with it, that must have proved a very great success. One can only imagine, and particularly from what is said in the paper, the filthy condition in which that brook must have been before it was culverted. I know wherever you get a built-on area next to a brook, unless very great care is taken in preventing it, the brook becomes the receptacle of all the filth that can be poured into it. I understand that was the case with this particular brook, and can imagine what it was like. I notice the portion of the plan exhibited which is coloured green. I take it that is intended to be laid out as a public park, recreation ground, or garden. Whether right or wrong in that supposition, I hope that may be carried out, because I am certain, in a district with a population of that kind, who appear, from what one can see, a very careless set of people, if you can lay out an open space or garden where the children can go and play, it keeps them off the streets, is very instructive to them, and leads them to think. Besides that, I believe that parks and gardens in squalid districts make people more careful in the upkeep of their own homes, and stimulate them in the care of their own houses.

Mr. D. M. Jenkins: I have very much pleasure in seconding the vote of thanks to the writers of the papers. I think all the members who saw the place in 1905 will agree that very effective work has been done, or will have been done when the development scheme is complete. It is a very striking testimony to the enterprise of the Corporation, as well as to the skill and foresight of the surveyor, Mr. Bell. Mr. Harpur has touched upon some aspects of the question which will commend themselves to the members generally. There is one remark in Mr. G. H. Bell's paper with which I fully agree, that is, that the housing problem in South Wales is one of the greatest moment. It is really exercising the mind and attention of the authorities, large and small, all over the country. In old towns like Swansea the housing problem is accentuated by the necessity of demolishing old houses and slums, and you have to

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provide dwellings for the people who are displaced by demolition schemes. No one can realise the seriousness of that problem until he comes into close touch with it. In the neighbouring town of Neath the housing problem has been in a more or less acute stage for some time. Since 1903 we have been constantly occupied with it. We have erected a large number of houses, and we are now engaged on a scheme for the erection of 93 houses, to be let at rentals of from 4*s.* 6*d.* to 5*s.* 3*d.* per week. I am afraid when that scheme is completed we shall have to enlarge our programme, and that is the case generally. In working out a scheme of that kind we have had to provide for the lower paid labourers, and that is the greatest difficulty in dealing with the problem. We have had to exercise the greatest restraint and economy in discriminating between what is desirable, on the one hand, and what is practicable within the limits of cost, on the other. That is a difficulty which the people who go about visiting these houses in an academic kind of way do not appreciate. I think the opportunity we have had to-day of seeing the work done by the Swansea Corporation should be a great advantage to us in our further efforts. The references in Mr. Swarbrick's paper to the Town Hill estate have been very interesting. Those of us who attended the South Wales Cottage Exhibition in Swansea about three years ago could not fail to be struck by the excellent lay-out of the part of the estate then dealt with, and by the potentialities of the whole district. I know Mr. Bell was at that time much occupied with the best means of transit between the estate and the town, and it is very interesting to know that a comprehensive system of tramways to serve this area is likely to become an accomplished fact. I think the Corporation have been well advised to acquire, at what may be a high price—some people would call it a fancy price—the extra land. I think a better site could not be found anywhere. A great deal of attention has been given to the planning of this area, and we have plans for our inspection which will be of the greatest value. We have not only a sort of picture to look at, but concrete illustrations of how the work is to be carried out, and, in short, we have a practical example of town planning under difficult conditions, which cannot fail to be of service to those of us who have to deal with the subject. It is known that Mr. Bell has devoted a good deal of time to this subject of town planning, and I

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think the Corporation of Swansea are to be congratulated upon having the benefit of the experience of one who has been for so many years in their service, and who so well knows the local conditions and requirements. They have also been well advised in securing the services of Mr. Raymond Unwin, who is one of the most brilliant exponents of town planning in the country. I should like to ask Mr. Swarbrick the approximate cost of the tramways on the system he has described, and whether rail corrugation, of which we have heard so much, has appeared on the system.

MR. J. MORGAN: It is a great pleasure to come here and see Mr. Bell's work, and the improvements which have been carried out since the meeting in 1905. We are erecting 28 houses at Pontardawe at the present time, and it has been a lesson to me to find the slight improvements upon our houses. There is one thing with regard to housing that is not thoroughly considered, that is the general neglect to provide accommodation for small families. I have failed to get my own Council's co-operation on that point. I wanted the Council to provide houses for both small and large families. The Council wanted to build houses for the better class working people, but the object is to provide for those who are turned out from houses which have to be demolished. We have 50 houses which are condemned, and the tenants will be turned out as soon as the houses we are erecting are completed. That is the object with which we are building houses, and I take it we shall have to go on building for the next two or three years, at any rate.

MR. H. C. PORTSMOUTH: In the Cwm Road scheme there are two classes of houses—25 of class A, which consist of a living-room, scullery, and one bedroom, and 25 of class B with a living-room, a scullery, and two bedrooms. The first cost 110*l.* each, and are let at 4*s.* per week, and the class B houses cost 145*l.*, and I believe they are let at 5*s.* a week. I was much struck by the remarks Mr. Morgan made as to small houses. A lot of people go through these houses and complain that they are too small: what is wanted is a house for a man and his family. I think these complaints are wrong because we have had ten times as many applications as there are houses. A speculative builder will not build houses of this kind. He wants to build a house of five or six rooms. These small houses are quite suitable for widows with one child, or for a man and his wife and no family. These small houses

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really meet a demand. There is another point as to cost. The class A type of house works out at 5*d.* per cubic foot, and the class B house at 4½*d.* per cubic foot, so that the smaller houses are rather more expensive in the matter of construction than the larger houses. Mr. Bell has referred to the foundation. I know he has taken care with the culverting there, but I took the precaution of putting a concrete raft 12 inches thick over the whole of the site, and there is no trace of any settlement. I consider that is a precaution which should be taken on a site of this sort. I thank you for the kind remarks which have been made as to these houses. I hope they will be successful, and will lead to the erection of houses of a similar type elsewhere.

Dr. Evans, Medical Officer of Health, Swansea: I am pleased to have been present at this meeting. I have a very great admiration for Municipal Engineers. Every time I have been in the Cwm Road, I have felt that the houses should never have been erected there at all, and that the Burlais Brook could have been cleansed. With regard to the tramways, I think that is an important subject, because it is so closely connected with the housing problem. Instead of building houses at Cwm Road we should have run the trams out to Cockett. There is plenty of land there. (A voice: And landowners.) Cheap trams are the solution of the problem. I think it would pay you from the housing point of view to run cheap trams and lose on them. We are losing on roads, and roads are only a means of transit as trams are a means of transit.

Mr. F. Read: I should like to have a little more information on the housing question. Most of us have looked into this question of cheap houses, and all who have spoken have found it was impossible to let the houses to cover expenses for anything like a rent of 4*s.* per week. In Swansea you seem to have achieved the impossible, and I for one should like to know how it is done. Take a house costing 135*l.*, and let at 4*s.* per week.

Mr. Portsmouth: I think you are wrong, the smaller houses are 110*l.*, and the larger 145*l.*

Mr. Read: I am speaking from the printed paper before me. The class B, consisting of one living-room, scullery, and one bedroom, is stated to cost 135*l.* Taking it at 20 houses to the acre, and allowing 800*l.* per acre for the land, and 10*l.* for the road, the charge on each house for principal and interest would be 8*l.* 6*s.* per annum; repairs, 2*l.*; insurance, 3*s.*; rates,

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2*l*. 8*s*.; so allowing nothing for establishment charges, there is an annual expense of 12*l*. 17*s*., and the gross income is 10*l*. 8*s*. —a loss of 2*l*. 9*s*. per annum on each house. I notice in the building of these houses the clinker was charged at 2*s*. 6*d*. per ton. Was that clinker broken up? I do not know how Mr. Bell had the conscience to charge 2*s*. 6*d*. per ton.

MR. BELL: It was broken and screened.

MR. READ: The enterprise of speculative builders does not keep pace with the demand for the houses, but if each house involves a loss of 2*l*. 9*s*. a year, the pace is much too hot for the local builders. I should like to know if my figures are anything like correct.

ALDERMAN JENKINS: I should like to refer to the remarks of Mr. Jenkins (of Neath) as to the cost of land at Town Hill. The cost of the land works out at 140*l*. per acre. We bought 130 acres at that price. We have a large estate of 600 acres there, capable of development. If we work that out on Mr. Raymond Unwin's scheme, and assuming that the development of the whole area takes thirty years, we shall be able to let the land at 2*l*. 8*s*. per house, which includes roads and sewers. If we average that for the whole area, and develop the estate in thirty years, it is equal to 200*l*. per acre on the whole of the land on the Town Hill estate. So I do not think we can say the cost of the land is excessive. Apart from that the land which we purchased from the Duke of Beaufort and other owners is practically the cream of the Town Hill land. If we had been unwise enough not to purchase that land we should have had to expend a large amount of money in obtaining access to the land. That is the land which will be first developed.

MR. H. A. CLARKE: I should like to congratulate the Authors of the papers, and express my gratitude for the information which has been given in Mr. Bell's paper. The Corporation and Borough Surveyor are to be congratulated upon the excellent results of their foresight in not only removing a menace to public health, but utilising to so good a purpose land which to the general mind was practically of no value. Those of us who saw the Pentre valley on the occasion of the Institution's last visit in 1905 must be much impressed with the possibilities of laying out such difficult spaces. The information given in respect of cottages erected, and to be erected by the Corporation is most interesting, and the proposal for developing the Town

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Hill is a bold stroke to relieve overcrowding, and to provide healthy homes for the workers. The tramways proposals explained by Mr. Swarbrick show clearly that Swansea is by no means an easy district to administrate and develop, and it is very evident that Swansea has in her representatives and officers men of sterling qualities. I congratulate the Authors of the papers, and express my gratitude to them for much information.

MR. A. J. OBORN: I should like to ask one question. As to the houses described in Mr. G. H. Bell's paper. He mentions a house costing 135*l.*, and consisting of one living-room, scullery, and one bedroom. Suppose the Corporation estate agent accepts a tenant for a house, it may be a man and his wife, and after he has been there some time the usual "encumbrance" appears, what action will the Corporation take under section 15 of the Housing and Town Planning Act?

MR. D. H. PRICE: My Council has had under consideration the erection of sixty houses on a site at an average of over 700 feet above sea level, a very salubrious spot between two valleys. The cost, however, is very much in excess of 200*l.* per house. There are more rooms in the houses, and we hope to cater for the better class workman. My Council consider that the average collier wants an extra living-room, in which to change his dirty clothes on returning home from work. We had a hard fight with the Local Government Board to get this extra room, but we have got it for thirty of the sixty houses.

THE MAYOR (MR. D. WILLIAMS): I want to compliment the writers of the two papers upon the selection of their subjects, both of which in reality have to do with the solving of the housing problem. I am not in accord with the building of the class of house we find in the Pentre Valley, but in present circumstances we have to meet the requirements of that class. I would prefer to build the better class of house referred to by Mr. Price, and bring the wages of the workers up to meet that requirement. The tramway and housing schemes are both parts of one great housing problem.

THE PRESIDENT: I should very much like to congratulate the borough of Swansea upon the activity they have shown in taking the housing question in hand, and their Surveyor for the way in which he has tackled it. It is obvious that the site might have been better, but it is still more obvious that the Authority which is alive and active is the Authority which does

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not waltz round a difficulty, but grapples with it and solves it. It is quite obvious that the borough of Swansea has a Council who are doing their duty to the ratepayers. It has been a great pleasure to me to see this work, good sound honest work, which will last for many years, and redound to the credit of the Corporation and their officers. It is clear, from what we have seen and heard to-day, that you cannot apply the same rules in dealing with varying local conditions. Take one instance in connection with the cottages described to us. I have been surprised that you have gone to the extravagance, as we should call it, of putting in hollow walls. I do not suppose there is one house in the Home and Midland Counties which is not built with 9-inch solid walls. You have to provide for the heavy rainfall and the dampness in the soil, and so meet your own local conditions. It is a credit to your Authority that you have, at the expense of the ratepayers, provided for those who cannot provide for themselves. It is not entirely a question for a Public Authority to see that their housing and other schemes are remunerative from the point of £ s. d. It is not a question whether a scheme will pay, but whether it will be for the health and well-being of the community. With reference to the tramways it seems to me they are very well laid. It is also interesting to find that your tramway engineer is in favour of a resilient track. We had a very interesting discussion in London a few weeks ago upon the corrugation of tramway rails. It was remarkable to find the variety of opinions as to the cause of corrugation; but, so far as I could find, the majority of the speakers were in favour of a resilient as against a solid track, as a means of reducing corrugation. It seems to me you have a very fine scheme for extending your trams up to the higher regions, but a gradient of 1 in 8 will require very careful consideration. It is a very steep gradient for the overhead system. You have no doubt had advice about it, and I trust it will turn out perfectly satisfactory and secure.

Mr. Wyrill: There are one or two points that occur to me from the engineering point of view in connection with the housing problem. Mr. Bell has expressed some doubts as to the erosive action on the culvert with a gradient of 1 in 8. I can assure you, from my own personal knowledge, that you need not be afraid of that action. Culverts are in existence lined with concrete, and not blue bricks as in this culvert, that are standing twice

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that velocity absolutely successfully. We have some of our culverts at Cray reservoir at a gradient of 1 in 10, which gives a velocity of 400 gallons against 164 gallons, and those are actually sound after a long working experience, and they are scoured out by water from the mountains which brings down a large amount of gravel and stone. If they stand that with rough concrete of 6 to 1, you need not have any fear of your blue bricks standing a velocity of 10 feet per second. You may be satisfied that is a permanent job. As to the question of rails, and jointing of rails on the tramways, that is more a question of practical engineering. It requires little observation to see if there is any deflection on the ends of the rail. You will have a fishplate 24 inches long, 10 inches wide, and $\frac{5}{8}$ of an inch thick. That may be all right, but in my opinion it requires to be supported properly by concrete. Mr. Swarbrick does not appear to have mentioned the thickness of the concrete and the support of the fishplate. I think if this is very thin you will have deflection of the rail ends, which will cause a certain amount of undulation in the tramcars, ultimately to the destruction of the track. I mention that respectfully as a matter which requires serious observation in the future experience of the track, because in having to sink down through the concrete to water mains I find there is a portion of the concrete which is absolutely knocked out of form, and if that is so it gives one the idea that it may be a source of weakness. It is a point which requires serious consideration. Another point concerning the houses which we have seen to-day, and it must be mentioned, because it appears to some Members who have come from other parts of the country to be extravagant to build houses with hollow walls. That is what we have to do, to apply ourselves to the conditions we have to meet. The hollow wall may not be necessary with a climate of 20 inches of rainfall. Here on the coast we have 45 inches, and the hollow wall is necessary. The hollow wall is sufficient up to 70 inches of rainfall, and above that we have to adopt extra precautions. In the district of Cray we have a rainfall varying from 80 inches to 110 inches. The caretakers' cottages are in a most exposed condition. The rain does not fall vertically but horizontally, because it is always blowing, and is always searching for a crack to get in. There we have first to saturate the wall with a coating of boiled oil brushed in with a thick brush, but I have had one case where

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that was not sufficient, and we grouted it with a solution of Portland cement. Where you have extreme conditions you must adopt extreme measures; so that the hollow wall with a rainfall of 45 inches is absolutely necessary. As to the Town Hill scheme, it is proposed to deal with that as a complete town plan. According to the arrangements there, I believe there is provision for 7000 population on the site south of the Town Hill. I think there will be accommodation for 10,000 people on the other side of the Hill. Taking the normal increase of the population of Swansea, that will fill up in a very short time. There is very little land in Swansea to build upon, and the population is beginning to overflow the borough in every direction. We cannot help ourselves, it is impossible to accommodate the population, and so the trams are necessary to get the people to their houses. The housing problem has become so serious here partly because of the proscribed area, and partly because of the abnormal prosperity of the district.

MR. DAVID JAMES, tramway manager: Twelve months since the new scheme came into operation, and the number of workmen carried has increased under the new conditions from 40,000 to 130,000 a month. During the past year we have carried 5½ million more workmen than in any other year. I think the Council of Swansea are working in a splendid manner for the prosperity of the town. That is proved by their kindly consideration in the concession, which is unique in the tramway world, of allowing workmen to travel at any time of the day for a halfpenny per mile.

MR. B. GRIFFIN: I am very much in favour of a resilient bed for a tramway track. It has always appeared to me that the rigid bed is the cause of tramway tracks shattering themselves. With four or five years' experience of a tramway laid with a resilient bed, I regard it as the best and most effective form of construction.

MR. G. SWARBRICK, in reply: At a meeting of Members of this Institution held last month, referred to by the President, at which a paper was read by Mr. H. T. Wakelam, County Engineer, Middlesex, on "Rail Corrugation," he stated that the replies received to questions circulated made it clear that corrugations were not caused by resilient tracks, and in this he was supported by Mr. Harpur (Cardiff), who stated, "that he rather fancied the rigid bed had a good deal to do with

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corrugation. Naturally if they had got two hard substances, one hammering upon the other, it had a bad effect on the rails, and more or less upon the wheels also. Mr. Harpur quite agreed with Mr. Wakelam that a certain amount of resiliency with stability was just the thing that was wanted, but the difficulty was how were they going to get that on the ordinary road. If they had a resilient tram track they must pull their paving to pieces; their paving must go with it or it was impossible to have a resilient track." Now, I think, after seeing the track and paving in High Street, which was laid four years ago and is subjected to very heavy traffic, the Members will agree that the paving has not been affected by the laying down of a resilient track, and if we have not actually got the ideal track it is a step in the right direction. There are several reasons for advocating a resilient track in preference to a rigid one. Every car, of the weight of an electric car, sets up a wave of vibration, as is generally admitted, when moving at any speed, owing to the inequalities of the surface, caused by mechanism slightly, and dirt on the track. This wave of vibration travels along the rail in front of the car, and reaching the joint, either, if the joint is tight, shakes and tends to loosen it, the joint being the weakest part of the rail, or, if the joint is loose, hammers the loose joint and sets up another wave both forward and backward of the car. Again if the joint is absolutely and perfectly rigid with anchors in a perfect mass of concrete, it will be found that there is no room for expansion of the rail at all, and the middle of the rail will move, either horizontally or vertically. Also where there is vibration it will be perfectly clear that a substance like steel will not be perfectly quiet on a substance like concrete, and it only takes time for the parging of the rail to crack, as well as the paving adjoining the rail. Then the water gets down and the rail becomes a sort of grinding wheel on the concrete with water and sand between the rail and concrete, so that it is practically impossible to try and get that rail tight again without stopping the traffic and packing. Now, with regard to a resilient or sleepered track, the vibration wave is at once deadened owing to the resilience of the wood. The sleepers being buried in and carefully packed with concrete, form a cushion which carries the rail. The size of the sleeper is big enough to absorb all vibration set up in the rail, and instead

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of that vibration being felt a long distance away from the approaching car, it is absorbed by two or three sleepers, the resilience of which, however, is not sufficiently elastic to allow either the parging or the adjoining paving being broken, owing to the fact that any vibratory blow is deadened in the first instance, owing to the presence of wood. Again at the points, it is essential to obtain as much strength as possible, in fact, to make the joint as strong as the rail, but care must be taken, in the design of this joint, that it shall not be too rigid and arrest the vibratory wave, but it shall be as strong as the rail, and also be resilient enough to allow the sleepers, which are placed directly under the sole plate, and 2 feet 6 inches either side of the joint, to at once absorb the vibration. The difference of arresting the vibration and absorbing the vibration is this. If a vibratory wave flowing along comes to a perfectly rigid joint it is arrested and thrown backwards along the rail, just like a ripple of water strikes a vertical wall, and then rebounds or breaks back again from the wall. In absorbing the vibration, there must be a resilient substance hard enough not to allow the rail to move, yet resilient enough to allow the vibration to be absorbed either totally or to a great extent in its cubical contents. Thus a small piece of wood, or thin sleeper is useless and the larger the sleeper the better, only for all commercial purposes, 8 feet by 9 inches by 4½ inches is large enough. A track laid with sleepers becomes more dead owing to this absorption, whereas a track where there has been an attempt to make it rigid, becomes more lively directly water is present, through the adjoining paving being broken by the vibration which is not absorbed. Again, when relaying the track, the levels and the bed are not disturbed, the only thing necessary is to draw the coachscrews, put in new rails, use a slightly larger coachscrew and repair, the concrete between the sleepers merely carrying the paving. Sleepers not creosoted and well packed in good concrete will last, I believe, two rails' life if not more, as they are completely embedded in the concrete, as will be seen on the detail drawings.

Mr. G. H. Bell: I thank you all very much for the kind vote of thanks to me for my paper. I have been very pleased that the papers have provided so excellent a discussion. I thank all the Members and visitors who have added so much information and knowledge on the subject.

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The Members made an inspection of the Castle Street improvement, and following luncheon, paid a visit to the refuse destructor works. After the discussion on the papers the Members were entertained to tea by the Borough Surveyor at the Hotel Cameron.

Re Castle Street, Swansea.—Mr. G. BELL writes: The improvement of Castle Street is a work that has been anxiously looked forward to by the inhabitants of Swansea for many years and is now, so far as the setting back is concerned, an accomplished fact. The old state of things was a great obstruction to intercommunication of traffic through the very heart of the town, and now this will be greatly facilitated, and connections will be made between the tramways which pass along the principal streets. The length of Castle Street is 400 feet, and its former width at narrowest parts only 18 feet. It has now been widened to 60 feet. The whole of the property on the east side, consisting of eighteen premises, was purchased and demolished. Six projecting premises on the west side purchased and set back. Six premises in College Street were purchased and pulled down, and the street widened to 46 feet 6 inches. Most of the property was acquired by negotiation under statutory powers included in Swansea Corporation Act, 1902. The total cost of the undertaking is about 166,000*l.* The surplus land was sold by public auction subject to ground rent, the revenue from which amounts to 4195*l.* per annum. Borrowing powers under the Act for this improvement fifty years.

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EASTERN DISTRICT. MEETING AT GERRARDS CROSS.

April 26, 1913.

Held in the Assembly Rooms, Gerrards Cross.

R. J. THOMAS, M.INST.C.E., PRESIDENT, *in the Chair.*

DR. J. H. WATERS, Chairman of the Sanitary Committee of the Eton Rural District Council, received the Members and gave them a most cordial welcome to the District. He stated that his pleasure was enhanced by the fact that the President for the year is the County Surveyor of Buckinghamshire, the County in which this meeting was being held.

The President thanked Dr. Waters, and expressed on behalf of the Members their keen appreciation of his kind words of welcome.

The Members then proceeded to the Sewage Disposal Works, which were formally opened by Colonel the Hon. W. Le Poer Trench, C.V.O., R.E.

The following paper was discussed.

THE MAIN DRAINAGE OF GERRARDS CROSS.

BY ARTHUR GLADWELL, ENGINEER AND SURVEYOR TO THE ETON RURAL DISTRICT COUNCIL.

THE parish of Gerrards Cross forms one of the nineteen rural parishes over which the Eton Rural District Council exercise jurisdiction, and is an entity of recent creation, having been

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formed (in 1896) a civil parish, by the grouping together of parts of five other parishes. The area of the parish is 2116 acres, and it is situate about three and a half miles N.W. of Uxbridge, four miles S.E. of Beaconsfield, and eighteen miles from London, on the London to Oxford main road.

The levels A.O.D. of the area now provided with sewers varies from 150 feet to 290 feet, the lower levels obtaining along the valley of the Misbourne river, while on the higher levels is situate the greater portion of the sewered area. The geological formation varies considerably, and consists for the most part of drift gravel with interstratified beds of sand, etc., overlying the Woolwich and Reading beds of the Lower Eocene, which in places outcrop to the surface, and which in their turn overlay the upper cretaceous chalk. In other places the beds of gravel are of considerable thickness, but the surface of the underlying clay being very undulating (as is usually the case in areas contiguous to the edge of the London Basin, as this is) in many places large volumes of water lying in the pockets formed by the surface undulations of the clay were encountered in the construction of the sewers, rendering the work at times difficult, dangerous, and relatively costly.

It is not unusual, in writing a descriptive paper such as this, to include a more or less lengthy, interesting, and accurate reference to the place and its surroundings, but in this connection the Author does not feel equal to the task of doing justice to such a subject, but contents himself by saying that the place itself is a gem of nature in a beautiful setting, making for health, and therefore joy, and lies surrounded by a wealth of interesting localities such as Windsor Castle, Eton College, Burnham Beeches, Stoke Poges (the burial place of the poet Gray), Beaconsfield, The Chalfonts (St. Peter and St. Giles), at the former of which places is to be found Jordan's Meeting House, where William Penn, the founder of Pennsylvania, lies buried, and at the latter Milton's cottage, where "Paradise Lost" was written at the time the poet was residing at Chalfont St. Giles; many other places of deep interest to the student both of nature and history lie within easy distance of this beautiful and interesting place.

Ten years ago Gerrards Cross was a hamlet of about two hundred and fifty inhabitants, and the population were for the most part grouped round the beautiful Common, but in April,

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1906, the new railway of the Great Western and Great Central Joint Committee was opened for traffic, resulting in the immediate and rapid development of the place as a residential area of the first order. Owing to the phenomenal development of building activity, added to the difficulty of providing a suitable and sufficient area for the disposal of sewage from cesspools, the question of the provision of main drainage became one of great and increasing urgency, and, acting on instructions, the Author, in February, 1910, presented a report to the Council on the whole question, which report advocated the provision of a scheme of sewerage and sewage disposal at an estimated cost of 28,000*l.* This report was adopted and the recommendations therein contained ordered to be carried out. The scheme was prepared and submitted to the Local Government Board. An inquiry was held by one of their engineering inspectors on May 12, 1911. The work was commenced in November, 1911, and is now virtually completed. The scheme is one of gravitation throughout, and comprises the construction of about ten miles of sewers of 15 inches, 9 inches, and 6 inches diameter respectively.

The design of the scheme of sewers presented one or two points of difficulty, a recital of which may not be without interest. In the first place, the level of the Amersham main road (along which the 15-inch diameter main outfall sewer has been constructed) at one point recedes in a contrary direction to the fall of the sewer; this necessitated the construction of the outfall sewer (for a distance of 700 feet) above the surface of the roadway. This was accomplished by obtaining an easement from the Great Western and Great Central Railways Joint Committee, which permitted of the sewer being constructed in cast-iron pipes on concrete piers at the foot of the embankment under the railway viaduct spanning the Amersham main road. In carrying out this work it was also necessary to slightly alter the line of road, which, by the consent of the county surveyor (our esteemed President), was accomplished at a reasonable cost. Had it not been possible to arrange the above details, as shortly described, it would have necessitated the construction of this outfall sewer at a gradient of 1 in 1000, whereas it is now constructed at a gradient of 1 in 600 for the whole of its length. In this connection it will be appropriate to mention that this outfall sewer is so constructed, both as to its diameter and gradient, as to terminate at a point (on the Amersham main road) at which the

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parish of Chalfont St. Peter (Amersham Rural District) adjoins Gerrards Cross parish, so that if in the future—near or remote—the duty devolves upon the Eton Rural District Council of receiving, conveying, and disposing of the sewage from the above-named adjoining parish of Chalfont St. Peter, preparation for such has already been made. Another difficulty which presented itself was consequent upon the fact that the new railway intersected (by a deep cutting) the area to be sewered. It therefore became necessary to design a distinct gravitation system for the areas lying on either side of the railway, the two systems joining at a point on the Amersham main road contiguous to the southern face of the railway viaduct which spans the road.

The depth of the sewers underground varies considerably, owing to the surface conformation of the sewered area. The deepest cutting was 30 feet, which was, unfortunately, in bad ground, and extended a considerable distance, but the Author is pleased to be able to say that, owing to the skill of the contractors and the excellent body of men in their employ, the entire work has been carried through in a most excellent manner without accident to life or limb, for which the Author is grateful.

Reference has already been made to the difficulty experienced in disposing of the contents of cesspools connected with the rapidly increasing number of houses within the area, and by the time the work of constructing the sewers was commenced this question became one of some complexity to the Parochial Sanitary Committee of the parish, and engaged the Author's serious consideration, with the result that he succeeded in arranging that, so soon as any length of sewer was completed, tested and passed, facilities should be given to owners whose properties abutted on the line or lines of such sewers to cause the drainage from such properties to be connected with the main sewer, preparations for treating the sewage thus admitted into the sewerage system having previously been made by adapting a small portion of the outfall site as an irrigation area. The first of such connections to the system was made on April 22, 1912, and the total number of properties connected with the system now exceeds three hundred and fifty. No difficulty whatever has been experienced in dealing with the volume of sewage upon the small area originally allocated; this provision has, the Author

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hopes and believes, been of considerable convenience to the residents, and has not been without its effect in the direction of economy in local administration.

But after all, the design and construction of systems of sewers for the conveyance of foul and effete matter is only a means to an end; the end being the satisfactory purification and disposal of the waste and discarded products of communities more or less populous, and it is in the satisfactory design, construction, and maintenance of works intended to effect this consummation that the greatest interest centres, and upon which no thought or study on the part of the public health engineer can be considered either misplaced or redundant. The subject of sewage purification and disposal is both a complex and fascinating one, not only on account of its inherent difficulties, but also on account of its extreme importance to the health and comfort of the community, and it is, therefore, to the question of the design of the outfall works connected with this scheme that the Author would more particularly call attention, albeit that by so doing he may be inviting an annihilating criticism from those of his *confrères* who are both more able and who are possessed of larger experience than he can lay claim to in this connection. The site upon which the outfall works have been constructed has an area of about 12¾ acres, and formed part of the estate of the late Mrs. Way, of Denham Place. The subsoil for the most part consists of siliceous gravel drift, and doubtless at one time formed part of the lagoon of the Misbourne river. The site may be said to be an ideal one for the purpose of the disposal of sewage effluent and would appear capable of absorbing an almost incalculable volume of such effluent. The irrigation area has been levelled and prepared for the cultivation of osiers. The outfall works are designed to effect the purification of the sewage from a population of 4500 persons, allowing 25 gallons *per capita per diem*, with provision for dealing with a flow of three times this volume, the dry-weather flow provided for being 112,500 gallons per day of 24 hours. The system of sewers is what is now known as the "partially separate" system, a certain volume of storm water from back roofs and back yards being provided for. The sewage, on first entering the works, flows through a screening and recording chamber into a set of six (three coupled pairs) detritus chambers, which are provided with sharply sloping floors designed to encourage the deposition of the grosser suspended solids; these

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chambers are fitted with deep scum boards, while in each is fixed a valve for the purpose of enabling sludge to be removed therefrom by gravitation to the sludge area. Fixed weirs are also provided at each side of the inlet channel, over which weirs all sewage exceeding in volume three times the dry-weather flow automatically escapes, and is conducted to either or both of two stand-by tanks, which are in their turn connected with special storm-water irrigation areas. Provision is also made for conveying any sludge deposited in these tanks to the sludge lagoons.

From the detritus chambers the sewage flows to a set of three continuous-flow liquefying tanks, the total capacity of which equals the daily dry-weather flow (112,500 gallons) to be treated. The effluent from the tanks will pass into the three measuring or dosing chambers which will be controlled by automatic dosing and recording gear; these dosing chambers have a greater depth than that necessary to contain the measured volume of effluent comprising each discharge to the spreaders; this provision is made with a view of arresting suspended solids which may be carried by the effluent leaving the tanks; such solids, in the form of sludge, being easily valved off to the sludge area. The ærobic bacteria beds, three in number, have each a diameter of 65 feet with a central annular opening 9 feet in diameter, and a depth of filtering material of 4½ feet, and are designed to treat the total volume of the dry-weather flow at the rate of 70 gallons per cubic yard per 24 hours. From the bacteria beds the effluent flows into a set of humus-tanks, the capacity of which equals one-twelfth the dry-weather flow. After passing through the humus-tanks the effluent is conveyed by means of stoneware pipe carriers to the various sections of the irrigation area where, owing to the porous nature of the soil, it will be readily absorbed.

DISCUSSION.

MR. E. WILLIS: I think I am voicing the wishes of the whole of the Members of the Institution present, as well as the many visitors, if, before opening the discussion on the paper, I propose a hearty vote of thanks to Mr. Gladwell, not only for what he has shown us to-day, but for the excellent paper he has presented to the Institution, descriptive of the new sewage disposal

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works. These papers are printed for the benefit of those Members who have not the opportunity, which some of us have, of attending the meetings. I should also like to include Mr. Roebuck, of whom Mr. Gladwell has spoken so highly, for the part he has taken in the carrying out of this scheme. I am sure we all owe a great deal to our assistants, and, unless we had their loyal and hearty co-operation, we could not do our work so well for the benefit of the local authorities which we serve. The site of the works seen to-day appears to me to have been excellently chosen. The difficulties of drainage in many towns are very great, and we have seen by the paper, and in the short distance we have travelled this morning, they were equally great in Gerrards Cross. Mr. Gladwell has succeeded in carrying out a complete gravitation scheme, thereby saving the district considerable outlay for pumping plant and corresponding maintenance charges in the future. In the site selected for the disposal works the land is specially suitable for sewage treatment, since it is a locality where the levels at which the sewage is received are considerably above the level at which the effluent is discharged into the river, and those levels have been utilised to the utmost in the design of the scheme. Mr. Gladwell is, in my opinion, very fortunate in having a variation in level exceeding 140 feet over the whole district. Unfortunately, in my district, where we have a pumping scheme, there is a variation of less than 30 feet, and some parts are below the level of high spring tides. Another point which appeals to many of us is that the tanks, filter beds, and chambers in the Gerrards Cross scheme are all arranged in triplicate. Many of us have designed tanks, etc., in duplicate, but I think it is better, where possible, to arrange them in triplicate. That has been done here, and will be found very useful in the future. The works, generally, are practically automatic, so that very little labour will be required, and the cost of maintenance should also be small. I wish to congratulate Mr. Gladwell and his assistant, as well as the local authority, upon the successful completion of the scheme.

Mr. H. Percy Boulnois: It is almost a pity that the works are so good, because we cannot have any of that annihilating criticism which Mr. Gladwell asks for. There can be no criticism of these works, and I will tell you why—they have passed the Local Government Board. If these works had been open to criticism the officers of the Local Government Board would

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already have done their duty. I must confess I was struck by the apparent simplicity of the works, and, after all, that is the great thing to achieve. Simplicity is the most difficult thing in science and art, and these works, from their very simplicity, strike me as being as perfect as such works can be, and I believe these works are entirely up-to-date. These works are designed for the treatment of a medium strength sewage. I would like to ask Mr. Gladwell how he got the Local Government Board to approve that strength when the quality of the sewage was unknown. Mr. Gladwell estimates that 25 gallons per person per day will give him a medium strength sewage, but how was it the Local Government Board allowed that, and did not insist upon the strong sewage formula? It is a very important point, because, in beginning sewage disposal works, the crux of the whole thing is—what is the strength of the sewage? Then what is the character of the land? Is it a light subsoil, or sand, or what is the land on which he passes his effluent? I should like to know the name of the stream into which the effluent flows, and whether it is a tributary of the Thames. With reference to the deep sewers [he mentions some of them 30 feet deep], I wish to know whether that is only the outfall sewer, or sewers to which houses will have to be connected. If the latter, a subsidiary sewer of less depth will have to be designed. Then who constructed the sprinklers? They seem to be remarkably good in design. I understand they are Stone's sprinklers, and they seem to be remarkably flexible; they were turning when we arrived at the works by the action of the wind, which shows that they are extremely delicate and performing their duty extremely well. It is a domestic sewage at the present moment, but if Gerrards Cross grows is it not possible that you will have some manufactories some day?—say, a big brewery in the future —and we all know what a difficult thing brewery waste is to deal with.

Mr. W. R. Locke: I should like to ask Mr. Gladwell if he thinks it is necessary to have humus-tanks when he is putting the effluent over the land. In my own district we have a fall from 500 feet to 200 feet, and we have to pump up all the sewage between 200 feet and 300 feet through a mile of rising main. I should like to congratulate Mr. Gladwell that he has been able to get the money to deal with his scheme in the way in which he has done.

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Mr. J. A. Webb: I should like to ask Mr. Gladwell, first, with respect to the sprinklers, whether the whole of the ball-bearings rest on the head, or whether the sprinkler is supported at the base by plates or double ball-bearings, otherwise, if the weight is on the head, I fear it will be prejudicial. Then I should like to ask if Mr. Gladwell has ball-bearings at the bottom as well as the top. If he has, it is an excellent idea, and not an expense in upkeep. Then I should like to ask Mr. Gladwell what pipes he has used, and whether he has used any special pipes in his deep sewer work where he has had to contend with water. If so, I should like to know whether iron or double-seal pipes have been used in the deep work. Another thing I would congratulate Mr. Gladwell upon is the additional humus-tank. We engineers, who have to deal with sewage, which we have to discharge into streams made up from the effluents from sewage farms, know the value of this additional humus-tank. Mr. Gladwell will not have an effluent to deal with for some years. The one thing I do object to, and it is a very minor one, is the arrangement of the scum boards. I would ask Mr. Gladwell to consider whether it would be advisable to do away with the open ends of the scum boards, so as to prevent the possibility of the wash of the humus. The boards are there to retain the humus at the bottom and allow the liquid to flow over the top, but with open ends it will tend to scour.

Mr. A. J. Martin: I was not at all sure that I should not be expected to sit here on a penitent form, arrayed in a white sheet, and carrying a candle, because my last appearance here was for the purpose of opposing the scheme. In justice to myself I must plead that I did not say a word against the scheme on its merits. It struck me as an excellent scheme. I did not envy Mr. Gladwell laying sewers 30 feet deep in a water-logged soil; but he seems to have come out of it very well. Having come here in the first instance to oppose him I should like now to congratulate him on carrying the work to a successful issue. It reflects the greatest credit on everybody concerned. With regard to the disposal works, I should like to echo what has been said as to their efficiency and simplicity. As far as one can see they are well designed and thoroughly well executed, and I have no doubt whatever that, if properly looked after, they will do all that can be expected of them. Mr. Gladwell is to be congratulated on his excellent outfall site. He should have no

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difficulty in getting an effluent (if there is an effluent at all) which will satisfy the Thames Conservancy. The cost of 28,000*l.* is not a trifle, even for a progressive and prosperous district like Gerrards Cross. In this connection I should like to quote a reminiscence of Sir Charles Cameron, who, entering a compartment of a railway train in which there was a very agreeable young couple, noticed their cheerful looks vanish as he came into the carriage. Presently, they came to a tunnel, and when they emerged from it Sir Charles said, "Young man, do you know what that tunnel cost to build? It cost 260,000*l.*" "Well, all I can say," the young man replied, "is, that it is worth every penny of the money." If these works cost 28,000*l.*, or even 30,000*l.*, they are worth every penny of the money. The first cost of the scheme will be practically the only cost, as there is no pumping or other heavy recurring expenditure. I must thank Mr. Gladwell very much for the opportunity of being present on this interesting occasion.

MR. W. E. EAVES: I congratulate Gerrards Cross and Mr. Gladwell upon the completion of this scheme. Like Mr. Martin, I was an opponent of this scheme for a neighbouring landowner. I can only say as far as one can see—apart from the position geographically, a position which I do not agree with as agent for that landowner; but, apart from that, the site is in every respect excellent and suitable.

The vote of thanks was passed unanimously.

MR. A. GLADWELL, in reply, said: I am very grateful that Mr. Willis, with his wide knowledge of sewage disposal matters, has let me off so lightly, and contented himself, as he has done, by simply proposing the vote of thanks. I am also grateful to Mr. Boulnois for having seconded it, because it gives me the opportunity of refreshing his memory on one point. One of the first questions Mr. Boulnois asked was, how did I arrive at the conclusion that this sewage was of medium strength. I perfectly well remember a certain occasion—one of many—when Mr. Boulnois was at the Local Government Board, calling on him without previous notice—and I never went there without coming away better informed—and referring to this very subject. He produced a key from his pocket, unlocked a drawer, and he gave me the very information which he has asked for to-day. So if Mr. Boulnois does not know how I got the information, I tell him and you that I got it from Mr. Boulnois, and I have

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worked on it from then until this day with excellent advantage. Of course Mr. Boulnois does not remember it, he would not have time to remember, if he lived to be a hundred, all the kind actions he has done for members of the Municipal Engineering profession. Classification of the sewage with which we have to deal into strong, medium, or weak, seemed after what I was told, more or less a matter of guesswork, and supplied me with food for considerable thought. Having regard to the local conditions, and to the fact that the houses in the district generally are large houses, each of which contains one or two baths, I decided that the sewage could not be weak, on the other hand, seeing that there are no trade effluents here to be treated, it could not be strong, ergo it must be medium, and following the line of least resistance, I resolved that it must be medium.

Mr. Boulnois: You have not answered how you satisfied the Local Government Board Inspector.

Mr. Gladwell: I can only assume that the Local Government Board and their Inspector were satisfied, because the scheme is now in operation. I did cite in my report to the Local Government Board, that I judged the sewage to be a medium one, and my memory is equally definite as Mr. Boulnois', though in a different direction, that the estimate of the strength of the sewage appears to have been proved. Now, as regards the deep sewers, that was one of the points of discussion between myself and the engineering Inspector of the Local Government Board at Whitehall, and, as a result of those interviews I decided that where any sewer was more than 10 feet below ground I would either bring up the connections to the different properties from the depth of the sewer or alternatively I would make a subsidiary sewer. I have adopted both those alternatives. Where it was cheaper to bring up each connection from the main sewer to the curtilage of the property, that system has been adopted, so that no owner of property has had occasion to go deeper than 10 feet into the ground for his connection. As to the sprinklers they certainly work very satisfactorily. They are of the "Stone" type, and are fitted with compensating arms which provide that when the flow from the measuring chamber commences, the whole of the arms come into operation, but when the head of effluent gets below a certain point the two compensating arms go out of action, and the remaining effluent is distributed by the other arms. That ensures that the spreaders

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will revolve with a low head of sewage, I trust Mr. Boulnois' prognostication as to having breweries here will never be realised, because it is one of the most difficult and refractory descriptions of sewage you can have to deal with. With respect to Mr. Locke's remarks, the humus-tanks may be considered by some engineers, in a scheme of this description, to be somewhat redundant. I do not think so. It appears to be a playful habit of the humus we have to deal with to coat itself in a sort of film over the surface of the land, and to destroy the value of the land, as an irrigable area. I thought it was better to err on the safe side of incurring some expense to ensure that the resultant effluent should have the best possible chance of being irrigated by the land over which it flows. Mr. Boulnois had said that I did not appear to have called attention to the quality of the land over which we distribute this effluent. I appear to have called attention to that at some length in my Institution paper. The land upon which we have placed these works forms part of the lagoon of the Misborne river, which has been restricted as to its capacity for mischief by being confined to a sort of channel. The character of the land is that of alluvial drift, free gravel, and when I tell you that in the execution of these works probably 4000 cubic yards of excellent washed ballast for the making of concrete for the construction of works, foundations, and so on, were obtained, I think it will be sufficient to convince you that the site is an ideal one for the distribution and irrigation of sewage effluent. I can assure Mr. Webb that the necessary weight to be sustained by the sprinklers is supported on four ball races, two at the head, and two at the foot, in addition to which there are side rollers to govern the oscillation of the sprinklers. That will account for the exceedingly easy manner in which they commenced to work this morning, and the velocity no doubt will be increased when they settle down to the work. I thought Mr. Webb was going to refer to the white tiles which we have made use of in the work for the resultant effluent to flow over. These are useful, inasmuch as you may observe whether the effluent is clear or not. Mr. Webb at another meeting criticised the use of these white tiles on the ground of their liability to be affected by frost, and the glaze coming off, but so far that has not occurred. Mr. Webb also referred to the scum boards in the humus-tanks. One lives and learns, and to a certain extent these humus-tanks—as all humus-tanks are—

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are more or less experimental as to construction. We all want to arrive at a certain result, and I am not certain it has yet been arrived at, but if, as Mr. Webb suggests, by the cutting out of a few holes in the boards better results can be obtained, they will be cut, but they will not be cut until I have satisfied myself that the present scum boards are a failure. The river Misbourne is a tributary of the Thames, first passing into the Colne; but as I do not propose to pass any effluent into the Misbourne river I do not think the Thames Conservancy officials will be unduly concerned about the quality of our effluent, but if they are I hope to be able to deliver it to them as pure as I have done at Burnham and Iver. As to the vote of thanks which has been proposed, I require no thanks, for, like my brother engineers, I love my work. I find the subject of sewage disposal a very fascinating one, and no work, no trouble, no study is too much to take if one can only obtain results, and if one man does get a wee bit in front of another the others can follow up, and it is up to the other man to do the job better. So does the science of sewage disposal advance, and so does all science advance, and if by a meeting of this kind any information can have been gained the day will not have been wasted.

Mr. Webb: I shall be glad to have an answer to my question as to the pipes used in the work, and if, owing to the difficult nature of any part of the ground, you were obliged to leave in any large quantity of timbering.

Mr. Gladwell: The pipes I used in this work, except in shallow places where it was necessary to employ cast-iron ones, have been entirely composed of Dorsetshire clay, and supplied from the Dorsetshire works, near Parkstone. The joints used in the deeper waterlogged areas were Hassell's double-lined joints. Wherever it was possible to avoid the extra expense of these pipes the joints have been made with tarred rope, followed by a fillet of cement. I look upon that as a very good joint. Although in many instances the saturation level of the subsoil water is 8 or 10 feet above the invert level of our sewers, I cannot say that the leakage into our sewers is at all appreciable. I think we have practically a watertight job. In connection with some of the deep cuttings, approximately from 25 to 30 feet, I found it necessary not only for the safety of the workmen but for the safety of the adjoining roads and property, to leave in a considerable amount of timber. But in connection

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with the contract, I made an arrangement that any timber left in should be paid for at the rate of 1*s*. 6*d*. per cubic foot. That is not pleasing to the contractors, as the timber costs more than that. The arrangement could not have been a profitable one for the contractors, as for every foot of timber left in they must have lost money. I tender to them my regrets, but I consider I have safeguarded the interests of my authority.

After the inauguration of the works, the Members of the Institution, together with Members of the District Council, returned to Gerrards Cross Common, where luncheon was served. Colonel Trench presided.

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NORTH EASTERN DISTRICT. MEETING AT NEWCASTLE-ON-TYNE.

May 2 and 3, 1913.

Held in the Council Chamber at the Town Hall, Newcastle.

R. J. THOMAS, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Members were received by the Lord Mayor (Alderman J. F. Weidner), who offered them a very cordial welcome to the town.

The Sheriff (Councillor J. T. Loriol) endorsed all that had been said by the Lord Mayor. He had read the papers, and considered them brimful of information.

The President thanked the Lord Mayor and the Sheriff for their very kind welcome. He felt sure that none could visit Newcastle without benefiting from an engineering point of view.

After the district business the following papers were discussed.

MUNICIPAL WORK IN NEWCASTLE-UPON-TYNE.

BY W. J. STEELE, M.INST.C.E. (*Member*), CITY ENGINEER, NEWCASTLE.

AT District Meetings of the Institution, it is usual for a description of the Municipal Works in the town where the meetings are held to be given, but as members of the Author's staff are contributing the following papers—Quayside Extension Works,

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Mr. Hubert Laws; Ouseburn Valley Works, Mr. F. I. Morgan, A.M.Inst.C.E.; Tramway Extensions, Mr. J. McKellar—these few notes will be of quite a general character.

Newcastle-upon-Tyne is essentially a city of commerce, and in the popular mind, the terms Newcastle and coal are synonymous. Whilst large quantities of coal are still won from some five collieries within its boundaries, and workings of great antiquity and extent exist under various parts of the city, at the present time it is the commercial, rather than the industrial, centre of the Northumberland and Durham coalfield. Shipbuilding, marine engineering, and the numerous industries attached to a shipping port, are its principal features. The city is situated on the north bank of the River Tyne, about seven miles from its mouth, and much of its progress is undoubtedly due to the fact that it rests upon what has been aptly expressed, a great commercial highway. In addition to Newcastle, and in close proximity thereto, the important boroughs of Gateshead, Jarrow, South Shields, Tynemouth, and Wallsend, lie upon the banks of the river, which, together with the adjacent urban and rural districts, form what is known as Tyneside.

River Tyne.

As the river plays such an important part in the life of the district, a little information concerning it may be interesting.

Between the seaward end of the Tyne Piers to Hedwin Streams, a distance inland of about 19¼ miles, it is controlled by the Tyne Improvement Commission, a spirited body which has carried out works of considerable magnitude in creating a safe harbour and navigable channel. For a distance of about 3¼ miles from the sea the channel of the river is being dredged to a depth of 30 feet, and for a further distance inland of about eleven miles to a depth of 25 feet, at low water of ordinary Spring tides. High water is about fifteen feet above low water of ordinary Spring tides. Vessels of between 3,000 and 4,000 net register tons frequently proceed to the Derwenthaugh Staiths, a distance of about fourteen miles inland. During 1912 2,132,494 tons of material were dredged by the Commissioners from the river and taken to sea. The largest quantity of coal and coke exported from the river in any one year was 20,543,683 tons, in 1911. During 1912, 94 vessels were launched into the river. This number included the battleship "Queen

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Mary," 700 feet long by 89 feet beam, from the yard of Palmer's Shipbuilding and Iron Company, Limited, Jarrow.

There are two docks on the north side of the river, and one on the south side. Those on the north side are the property of the Commissioners, the respective water areas being, Northumberland Dock 50 acres, and Albert Edward Dock 22¼ acres. Tyne Dock, on the south side, is the property of the North Eastern Railway, and has a water area of 50 acres. The gross revenue receipts of the Commissioners in 1912 were 441,000*l.*, but in 1911, when there was no miners' strike, they were 483,005*l.* The revenue expenditure in 1912 was 313,373*l.*

A somewhat striking feature of the river is that it has a considerable reputation for salmon fishing, and in spite of being so much used for industrial purposes, large numbers of these fish are taken every year from the upper reaches.

NEWCASTLE QUAYS.

This undertaking is the property of, and controlled by, the Corporation. It extends from the high-level bridge to a point about one hundred and twenty yards east of the Ouseburn, a tributary of the river, and is about 1,842 yards in length. The imports and exports at the Quay are grain and general merchandise, no coal being shipped here. During the last year, the number of vessels arriving and departing from the Quay was 1,810, and the total volume of trade was over 500,000 tons. The general depth of the water at L.W.O.S.T. varies from 12 to 20 feet, but in all new work provision is being made for a depth of 25 feet, or 40 feet at H.W.O.S.T. Since 1908, the railway along the Quay has been relaid, the road repaved in wood or granite setts, three transit sheds built, new approach roads constructed, and electrical cranes with other dock equipment installed, for improving the facilities of the undertaking. East of the Ouseburn, the quay has been extended, which work is to be described in a paper by Mr. Hubert Laws, as previously mentioned. A contract has just been let for the reconstruction of the London Wharf. This is a timber quay providing for a depth of 25 feet at L.W.O.S.T., the longest piles being 57 feet. The drawings are submitted for observation. A new transit shed is to be erected at this wharf, and another immediately west of the Ouseburn, but the drawings are not in a sufficiently advanced stage for exhibition.

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Water Supply.

An abundant supply of water of excellent quality is provided by the Newcastle and Gateshead Water Company, and the Author is indebted to Mr. A. L. Forster, M.Inst.C.E., the engineer to the company, for the following information. The company, which came into being in 1845, is the successor of numerous other companies, the first Act of Parliament being obtained in 1699, by William Yarnold, an attorney, from New Woodstock, in Oxfordshire. There is a trade supply and domestic supply, respectively. In the event of a shortage of water from the drainage area, the trade supply is pumped from the River Tyne at Wylam into the trade reservoir at Whittle Dene, about twelve miles from the city, from whence it is distributed to manufactories on both sides of the river. The domestic supply is obtained by impounding the waters of the River Pont and several burns, by means of reservoirs at Whittle Dene, East Hallington, West Hallington, Little Swinburne, and Colt Crag, respectively, and situated at distances from the city, varying from 12 to 24 miles, and also by impounding the River Rede at Catcleugh, 4 miles from the borders of Scotland, and about forty-one miles from the city. The reservoir at Catcleugh, whose top water-level is 815 feet above Ordnance Datum, has a capacity of 2,305 million gallons, and is calculated to give a daily supply of about nine million gallons. Showing the excellent position of this reservoir in relation to the drainage area, there has annually passed over the overflow to waste, quantities varying from 3,383 million gallons in 1908, to 8,223 million gallons in 1912. The whole of the domestic supply is filtered. In 1912, the total population supplied was 575,000, the consumption 19 million gallons per day, the storage 5,366 million gallons, and the drainage area 32,470 acres. The charges for trade supply are on a sliding scale, for the low service from 1*s.* to 5½*d.* per 1000 gallons and for the high service from 1*s.* 2*d.* to 7½*d.* per 1000 gallons; for public purposes from the domestic supply, 5*d.* per 1000 gallons.

Drainage.

The city may be said to be particularly fortunate in its drainage, as, with the river as an outfall and no treatment of its sewage, the total annual cost of this service, including capital charges, is the comparatively small amount of 1·08*d.* in the £, the

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cost of maintenance only, being 0·63*d.* in the £. In some quarters, it is held that the sewage should not be permitted to enter the river in a crude state, but its treatment, or interception by a culvert by which it would be made to discharge directly into the sea, would be such a costly undertaking that an exceptionally strong case will have to be established before the present means are altered. The city is built on land sloping towards the river. For a distance varying from 400 to 700 yards, the slope is rapid, the gradients of many roads being 1 in 7, but from the top of this slope, northward to the boundaries, it is gradual; the general level of the highest part of the city is about three hundred feet, and the lowest, about fifteen feet above Ordnance Datum. Several valleys running in a northerly direction from the river, formerly divided the present area, but many of these have been filled in. With such a configuration, the inclinations of the main sewers are of course generally good, and although a certain number of the sewers are of considerable age, and therefore not in an ideal condition, systematic flushing enables them to fulfil their functions in a reasonably satisfactory manner. In the case of new branch sewers, the conditions of each case are of course considered, but with the object of saving repetition in calculation, the following rules have been formulated, and generally speaking, can be observed.

SIZE AND INCLINATION OF SEWERS.

Internal diameter of pipe.	Inclination.		Number of houses to be drained.	
	Minimum.	Maximum.	Minimum.	Maximum.
6 inches	1 in 48	1 in 8	1	15
9 ,,	1 ,, 64	1 ,, 5	16	100
12 ,,	1 ,, 96	1 ,, 10	101	200
15 ,,	1 ,, 120	1 ,, 10	201	300
18 ,,	1 ,, 120	1 ,, 10	301	400
21 ,,	1 ,, 150	1 ,, 10	401	700
24 ,,	1 ,, 150	1 ,, 10	701	1000

LIGHTING.

In addition to the Newcastle and Gateshead Gas Company, two Electrical Companies—the Newcastle-upon-Tyne Electric Supply Company, Ltd., and the Newcastle and District Electric Lighting Company, Ltd., respectively—supply the means of light,

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in addition to which the Corporation, through its Tramways Committee, provide the public street arc lighting. It will be seen that the means are plentiful, and the service is not only efficient, but moderate in cost. The charges for private lighting are $3\frac{3}{4}d.$ per unit, with 5 per cent. discount, for electrical current, and 2*s.* 1*d.* per 1000 cubic feet, with a minimum discount of 10 per cent., for gas. The street lighting is controlled by a sub-committee of the Watch Committee and with its lighting inspector, Mr. George Lamb, has given considerable attention to the automatic lighting and extinguishing of gas lamps, and the use of high-pressure gas. At the present time, 3,497 out of a total of 9,048 street gas lamps, are automatically lighted and extinguished by a system of wave pressure from the gas works; this system has given such satisfactory results that it is to be extended to the whole of the lamps. Like all automatic methods of lighting and extinguishing, it of course has the slight disadvantage of requiring a pilot light, consuming 0·20 cubic foot per lamp per hour, during daylight hours, but this is unavoidable. In Grey Street, seventeen lamps have been supplied with gas at a pressure of 80 inches against the average low pressure of 4 inches, which gives a candle power of 1,500 per lamp. The number of electrical arc lamps is 428, and electrical incandescent 399, so that the total number of public street lamps is 9,875.

Highway.

The wood-paved surface of the highway, with the exception of a very small area, is wholly composed of jarrah wood, and has proved to be very durable. The blocks are wholly immersed in refined tar before being brought to the site of the work. In four streets for which a loan has just been obtained, creosoted redwood is to be used, owing to the gradient being unsafe for hardwood. The stone sett-paved roads are principally surfaced with granite from Aberdeen. On gradients exceeding 1 in 10 sandstone setts are used with great success; although somewhat costly, this surface is safer for traffic than bituminously bound macadam, and water-bound macadam is difficult to keep in place.

The Northumberland whinstone exclusively used for ordinary macadam surfaces, is an excellent road stone, and costs an average of 7*s.* 11*d.* per ton at the various railway stations. In repairs, the stone is laid and thoroughly rolled without water, a mixture

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composed of pitch and creosote oil, heated to boiling point, being then poured into the interstices. The top is then covered with ¾-inch steel slag or whinstone, lightly covered with the pitch mixture, and finally sprinkled with clean dry sand, and thoroughly rolled again. In all streets constructed under the Public Health or Local Acts, tarred slag on a hand-packed stone foundation, 8 inches in thickness, is exclusively used for the carriageway. The thickness of this "tar macadam" is 5 inches, separately rolled in three layers, the first being 3 inches thick of 2-inch material, the second 1½ inch thick of 1-inch material, and the topping ½ inch thick of ⅜-inch material. The cost per square yard, including foundation, is about 5*s.* 6*d.*

A large proportion of the surface of the highway (over 100 miles) is paved with granite or whinstone chips, a species of "rag pitching." This surface has only one advantage, although that is somewhat important—its maintenance costs are low. Each year, as funds permit, a number of streets are re-surfaced by laying tarred slag on the surface of the chip paving. During the last three years about three miles of road have been treated in this manner. The cost is about 2*s.* 6*d.* per square yard. With one or two exceptions, the results have been good; the exceptions have not been successful owing, so far as at present known, to water having percolated through the new surface to the old depressions in the chip paving, and this having been more or less impervious, traffic has forced the standing water into the macadam, and in time caused disintegration. The total cost of maintenance of the highway for the current year is the comparatively low sum of 26,000*l.*, and is equivalent to 4*d.* per £ of the rateable value.

New Buildings.

Like every town, the last few years have been remarkable for a notable decline in the erection of dwelling-houses. A chart is submitted showing the houses erected each year since 1882, and the approximate value of the work included in the plans approved under the by-laws for each year since 1910. In 1912 new by-laws for new buildings and streets were made and *inter alia* provided for reinforced concrete buildings and steel-framed structures, although many such were erected before this date. The by-laws provide that when plans are deposited for buildings of this character, the applicant shall submit detailed drawings

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and calculations of every part of the structure. The work of checking these drawings and calculations has, of course, considerably increased the work of the department, but whilst the local authority may not be legally liable for any failure in a structure approved under the by-laws, there is a moral responsibility, consequently it is necessary for such work to be done. From his experience in the use of reinforced concrete, and the supervision under the by-laws of buildings erected in this method of construction, the Author is of opinion that too much care cannot be taken in design and execution. In the working stresses sanctioned by the rules of the Royal Institute of British Architects, the concrete is allowed a working stress of 600 lbs. per square inch in compression. This is a reasonable allowance with sound concrete, but as the members of this Institution are well aware, there is an exceedingly wide latitude in the strength of this material, as its strength depends upon such a variety of conditions.

In some tests recently carried out as detailed in the paper by Mr. F. I. Morgan on the "Ouseburn Valley Works," to be submitted to the Institution at this meeting, test cubes of concrete of a proportion of 4½ of gravel and sand to 1 of cement, made under most rigid conditions, three months old, failed under an average compressive stress of 2,432 lbs. per square inch, or about four times the stress allowed, which is a small factor of safety when the variable nature of the material is considered. With the present severe competition in this method of construction and the sometimes doubtful character of the concrete and its application to the reinforcement, where the structure is designed upon the stress allowed by the Royal Institute of British Architects, it is desirable for a careful examination to be made during every stage of the erection of a building. It is obvious that the inspectors employed by a local authority have insufficient time to act as clerks of works upon buildings, therefore any proposal to depart from regulations now generally accepted as applying to this form of construction, is only approved of on condition that the principal members of the structure are tested with a load equal to its full calculated working load.

The granting of a licence under the Cinematograph Act, 1909, is vested in the Corporation. The remarkable growth of this class of entertainment has been such that there are now twenty-one halls devoted to it, in addition to which there are

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four theatres and three music halls. Supplementary to police supervision, an inspector attached to the Author's staff, makes systematic inspection during the performances, to ascertain that the regulations are complied with.

Town Planning.

Newcastle was a walled town with towers at numerous points in the length of the wall, and there are several portions of the wall, with some of the towers, still standing in a good state of preservation. Owing to the marvellous foresight of Richard Grainger, a prominent contractor, assisted by John Dobson, an architect of unusual ability, a large part of the central area of the city was rebuilt between 1834 and 1845, with a spirit revealing a remarkable breadth of view in the planning of an important town. The principal streets in this area are Grey Street, 73 to 80 feet in width, Grainger Street, 63 feet in width, Clayton Street, 50 feet in width, and Market Street, 63 feet in width, together with several connecting streets on the same bold plan. Grey Street is a symmetrical curve on plan, with a gradient of about 1 in 21, and forms a thoroughfare of striking dignity. The architecture is classical throughout, the whole of the many handsome buildings being built in stone. This is an example of the fact that "Town Planning" is only a revival of the bold ideas that animated some of the citizens of our towns, and it is a matter for regret that during the last 70 years commercial competition has demanded that everything should be sacrificed to immediate needs.

By general consent, if the provisions of the Housing and Town Planning Act, 1909, are carried out in a reasonable manner, the areas still to be developed will at least be an improvement upon the wearisome monotony of the streets in the modern suburb. Operations under the Act have been commenced in two areas. The smaller area (53½ acres) is partially within the city and partially within the district of the Gosforth Urban District Council. The Local Government Board have sanctioned the preparation of a scheme, after inquiry, and the draft scheme is in preparation. The larger area (1,540 acres) is wholly within the city except a small portion in the borough of Wallsend and the district of the Longbenton Urban District Council, respectively. In this area the Corporation own about 749 acres of the land; the first notices under this area have

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been served prior to the inquiry by the Local Government Board.

Some little difficulty has been experienced in defining the boundaries of the scheme, as the adjoining authorities very properly regard an intrusion in their district as an act requiring careful consideration. From a town-planning aspect, the boundaries of the city are not suitable in every part, as one of the cardinal principles of the Act is that any projected roads or other requirements shall be of full service to the general public, irrespective of the boundaries of a town or the ownership of land; conferences have been held with representatives of the local authorities concerned, with the object of arriving at such areas as shall be mutually satisfactory.

Another feature which has demanded consideration is that of cost to the local authorities and owners of land respectively. If a scheme requires a road to be forthwith constructed at the cost of the owner, he may suffer an injustice, as he may thereby incur an expenditure many years before receiving any income from the development of his land; on the other hand, if the local authority bears the cost of construction, the general body of ratepayers are carrying a burden that should be borne by the landowner. Of course it may be held that the local authority should bear the cost and recover it from the owner when the land is in a certain state of development; this seems the most reasonable way out of the difficulty, but considerable discretion is necessary in fixing upon the roads to be forthwith laid out.

Parks and Open Spaces.

The citizens are justly proud of the numerous parks and open spaces. Inclusive of the Town Moor and Castle Leazes, the total area is 1,295 acres, or more than 15 per cent. of the total area of the city. Exclusive of the Town Moor and Castle Leazes, the aggregate area of parks proper is 285 acres. An interesting point for discussion might be raised as to whether such a large proportion of the total area of the city as is comprised in the 1,010 acres of the Town Moor and Castle Leazes, situated in one district, does not make for too close building in other districts, inasmuch as it inevitably influences the value of the land in the central zone. If, say, 200 acres of the Town Moor were developed for building purposes, there would remain some 727

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acres, which is an abundance, in one complete open space, for any provincial city. Instead of great areas of land, often inaccessible to a large number of the inhabitants of the town—except on rare occasions such as a public holiday—being given up for one or two public open spaces, more space is required about the dwellings, together with small ornamental spaces in the midst of the dwellings.

The principal park is that known as Jesmond Dene. Formerly the private grounds of the late Lord Armstrong, that munificent benefactor to the city presented it to the citizens in 1884. Its natural beauties were very greatly enhanced by the unique taste of the owner, and when the rhododendrons are in full bloom it forms a place of infinite charm. A striking feature of the parks is the extent to which the games of bowls, lawn tennis, boating, etc., are indulged in. For the year ended March 31, 1912, the receipts derived from these games amounted to 1,132*l.*, of which 633*l.* was received at the bowling greens, there being twenty of these greens distributed over the various parks.

Street Cleansing and Refuse Disposal.

The humble but essential duty of removing refuse from the highways and dwellings of the citizens, is one which presses with much greater force as our knowledge of public health administration is increased.

The house refuse is disposed of by—

1. Burning at one of the three destructors, about 34,000 tons per annum.
2. Conveying by means of hoppers, to a point not less than 3 miles outside the piers at the mouth of the river, and discharging it into the sea, about 35,000 tons per annum.
3. Given to farmers who receive it at certain goods stations in the city, about 9,000 tons per annum, and
4. Discharged on tips within the city boundaries, about 12,000 tons per annum.

Destruction by burning is undoubtedly an effectual method of disposal, but it is comparatively costly. The nett cost per ton, inclusive of capital charges, is 1*s.* 11*d.* at the Byker destructor, 3*s.* 3*d.* at the Walker destructor, and 5*s.* 4*d.* at the Benwell destructor. The nett cost per ton of sea disposal is about 1*s.* 7*d.*

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The unusually high cost at the Benwell destructor, is largely due to the capital charges, which amount to 3*s.* per ton, the site being a very costly one.

The quantity amounts to 6½ cwts. per head per annum, or an average of 35 cwts. per house, and including capital charges, costs 1*s.* 11·54*d.* per head for collection and disposal, or an average of 10*s.* 6*d.* per house.

The street refuse is disposed of—

1. Discharged on fields and tips within the city boundaries, about 32,000 tons per annum.
2. Given to farmers, about 8,500 tons per annum.
3. Conveyance to sea, „ 4,800 „ „ „

The quantity collected per annum amounts to an average of 181 tons per mile of highway cleansed, and its cost of collection and disposal to 2*s.* 2*d.* per head of population.

Costs of Maintenance.

The maintenance costs only, of some of the municipal services for the year ended March 31, 1912, are given below:—

Fund.	Per head of population.	Per £ of rateable value.
	d.	*d.*
Macadamised roads	8·39	1·37
Flagging and paving (inclusive of wood paving, granite paving, and chip paving)	11·88	1·94
Sewers (inclusive of flushing)	3·86	0·63
Street watering	1·46	0·24
Street cleansing	25·83	4·21
Snow removal	1·24	0·20
House refuse removal and disposal	21·12	3·45
Public lavatories and urinals	1·98	0·32
Town moor and parks	8·64	1·41
	84·40	13·77

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QUAY EXTENSION WORKS AT NEWCASTLE UPON-TYNE.

By HUBERT LAWS,
Resident Engineer in charge of Works.

When it is considered that the city of Newcastle owes so much of its prosperity to the River Tyne, it is not surprising that for a long time works of quay improvement have been a very important duty of the Corporation. From the twelfth century, and probably even earlier, the conservancy of the river was vested in the Corporation, but in 1850 the passing of the River Tyne Improvement Act entrusted the management of the tidal portion of the river, extending from the Bar to the Hedwin Streams, a distance of about 19 miles, to a Commission, now known as the Tyne Improvement Commission. At this period the condition of the river was very bad for navigation, there being practically no depth at low water, and the channel having many awkward points and obstructions. It was then a common occurrence for ships to go aground on the various shoals, while vessels drawing 18 feet to 20 feet could only cross the bar at high water, and it was impossible for any of a greater draught to enter the river.

River and Quay Improvements.

From 1854, however, great improvement works have been carried out by the Tyne Improvement Commission, including the construction of the North and South Piers, the removal of the bar and formation of a deep-water channel from the sea to the Hedwin Streams, the construction of the Northumberland and Albert Edward Docks, the removal of the old arched bridge at Newcastle, which was a great obstruction to traffic, and its replacement by the present hydraulic swing bridge (opened for traffic 1876), etc. A huge amount of dredging has been carried out, and there is now a depth at low water of from 25 feet to

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30 feet or upwards from Newcastle to the sea. With these great improvements taking place in the river, and the increase in the size and draught of ships, it became necessary for the Corporation to reconstruct their old quays and make extensions. Before the year 1763 the Town Wall ran along the Quay, water-gates connecting the town with the river, but in this year it was pulled down. In 1807 an old history describes the Quay as "one of the most commodious wharves in the kingdom, since the removal of the old town wall." In 1830 the quay extended from the old Tyne Bridge to the Milk Market, a distance of about one thousand five hundred feet. Between the years 1837 and 1866, under Acts of Parliament of 1837 and 1855, the quay was extended to the east, its total length then being 3345 feet. These old quays were of light construction, being founded on short timber piles, and the depth at low water in front of them varied from 2½ feet to 5 feet. They were not of sufficient strength to allow of deep berths being dredged. In 1866 a commencement was made with a permanent type of quay, built on cast-iron cylinders, and this was carried from the termination of the existing quay eastward to the Ouse Burn, whilst between 1872 and 1879, under the Acts of 1865 and 1870, certain sections of the older quays were rebuilt on cylinder foundations. During this time various sheds were erected, railways laid, and other subsidiary works carried out.

From 1888 to 1902 further sections of the old quay walls were reconstructed on concrete well-monolith foundations, the walls being designed to allow a depth of from 20 feet to 25 feet at low water ordinary spring tides. The quay now extended from the Swing Bridge to the Ouse Burn, a distance of about four thousand six hundred and twenty feet, and with the exception of the old London Wharf and another short length of quay on timber piles, was all constructed on cylinder or monolith foundations, the former quays being dredged to from 15 feet to 20 feet, and the latter to 20 feet below low water O.S.T. The extreme narrowness of the quay, shortage of berths, and difficulty of coping with the increased traffic being severely felt, the Corporation in 1904 obtained an Act granting powers for further improvements and extensions, so as to more adequately deal with the demand for better facilities. By this Act, the Corporation, in addition to improvement works on the existing quay, were empowered to construct a new quay on the east side of the

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Ouse Burn, with bridges, railways, sidings, sheds, and other equipment required. The amount sanctioned in the Act for works of quay improvement was 200,000*l.*, and for quay extension works 313,000*l.*, and it is with the construction of the latter works that this paper will deal.

Quay Extension Works, East of Ouse Burn.

In 1906 the eastern limit of the permanent quay was the west side of the Ouse Burn. The Ouse Burn is a stream which flows in a southerly direction through the city, discharging into the Tyne about three-quarters of a mile east of the Swing Bridge. The stream is tidal for about half a mile from the mouth. The Burn, which is narrow in its upper reaches, had here a width of about 50 feet, and was crossed by an old stone arched bridge, known as the Glasshouse Bridge, built in the year 1669, and having a span of 43 feet 3 inches, a width of 8 feet 7 inches between the parapets, and a headway of 9 feet 11 inches above high water O.S.T. On the east side of the Burn was an old stone quay, built on the foreshore, of irregular line and in a very dilapidated condition. On and behind this quay some very old property existed, including a disused bottle works of ancient origin, the district being the site of the old glass-making trade which dates back to the time of Queen Elizabeth, and was at one time a very flourishing trade in Newcastle and Gateshead. The ground was of a very irregular nature, rising rapidly to the north, a steep, narrow, zig-zag road, connecting the quay with the main road to the city (Plate 2, Fig. 3). The scheme sanctioned by the 1904 Act included the construction of a deep-water quay on the river front of a length of about one thousand one hundred and thirty feet and a short length of quay in the Ouse Burn, the building of a low level bridge with a square span of 55 feet and a width of about sixty feet over the Burn with the necessary approaches thereto, the building of a high level bridge connecting the quay with the City Road by means of an inclined approach road, having a gradient of 1 in 35, together with railways, sidings, roads, sheds, cranes, and other equipment required.

In May, 1906, the City Engineer, Mr. C. R. S. Kirkpatrick, M.Inst.C.E., presented a scheme to the Trade and Commerce Committee embodying a portion of the above proposals. This scheme comprised the building of a deep-water quay wall, 360 feet

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in length on the river front, and 120 feet long on the east side of the Ouse Burn, a low-level bridge over the Ouse Burn with approach roads, railways and sidings, the formation of a quay about one hundred and forty feet in width, with heavy retaining wall at the back and new approach road, and building a transit shed 240 feet in length by 70 feet in width (Plate 2, Fig. 4). The estimated cost of this scheme was 59,537*l.* The scheme was approved by the Council in July, 1906, and negotiations were entered into to acquire certain lands and properties belonging to private owners. These negotiations were somewhat protracted, and the work was considerably delayed owing to the whole of the site not being available at the commencement. It was at first proposed to build the quay on ferro concrete piles, but on account of the nature of the foundations and the depth of dredging afterwards to be carried out, provision being made for a depth of 25 feet below low water O.S.T., it was decided that the foundations should consist of concrete well-monoliths, 30 feet by 20 feet. This type of construction had been recommended to the Council by the late Mr. W. Geo. Laws, M.Inst.C.E., and the late Mr. P. J. Messent, M.Inst.C.E., in 1888, and several sections of wall had been successfully built in this manner between 1888 and 1906. The foundations for the quay wall consisted of fourteen monoliths, each 30 feet by 20 feet, and one monolith 26 feet by 20 feet, and for the low-level bridge of six monoliths, each 22 feet by 15 feet, together with two monoliths at the south-west corner of the bridge, each 15 feet by 15 feet (Plate 1, Figs. 1 and 2).

Preliminary Work and Temporary Stagings.

Plans of the works and of the temporary staging having been deposited with the Board of Trade and the Tyne Improvement Commission, and a contract let for the construction of the monolith shoes, a commencement was made on a portion of the work in October, 1906. It was decided that the work should be carried out direct by the Corporation, as the previous monolith quays had been, and not let by contract. After the site had been fenced in, the preliminary work of demolishing the old buildings, and levelling the ground was proceeded with. The excavated material was sent to sea in hoppers carrying 240 tons each, the cost of waterage being from 6*d.* to 7½*d.* per ton. The materials from the old buildings were mostly sold on the site,

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though part of the stone was retained for future use. The temporary stagings for the monolith sinking were next undertaken. Two stagings were erected, the front one being on the river-side of the line of proposed monoliths, to carry the cranes to be used in the grabbing operations for sinking the monoliths, and for delivery of cement, gravel, and other materials from craft on the river, and the back staging to carry cranes used for concreting, erecting standards and shutters, moving kentledge blocks, etc. The front staging was about thirteen feet wide, and carried on two rows of 12-inch by 12-inch pitch pine piles, spaced 10 feet centres, and from 50 feet to 57 feet long. The deck level of the staging was at about six feet above high water, and a crane track was laid the full length of the staging. Previous monolith sinking on other sections of the quay works had shown the advisability of driving the piles for the temporary staging down to nearly the same depth as that to which the monoliths were to be sunk, as otherwise the ground was apt to become loosened by the sinking, and the piles being disturbed would move out of line or sink, causing trouble with subsidence and movement of the staging. In the present case in spite of these precautions the staging moved out of line a trifle during the sinking and also subsided slightly in parts, but the amount was only small, and it was packed up, no damage occurring. The back staging was from 15 feet to 20 feet wide, also carried on two rows of piles driven to a similar depth to the front piles, and the ground behind was close timbered to prevent any material being washed out by the action of the tide and causing subsidence of the ground retained. The piles, which were driven to a depth of between 30 feet to 35 feet below low water O.S.T. were exceedingly difficult to drive, the ground being very hard almost from the commencement. A large part of the driving was through very stiff boulder clay, and the difficulty of driving the piles to the desired depth foreshadowed the trouble which was afterwards experienced in sinking the monoliths. Whilst the staging was in course of erection, work of excavation and diversions of water pipes, gas pipes and sewers were being proceeded with, and the monolith shoes, straps, timbering, and shutters prepared. Between the two stagings which were placed 25 feet apart, the ground was excavated to a depth of 4 feet above low water, and a level bed prepared on which the monolith shoes could be set.

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Monolith Shoes and Monolith Building.

The monolith shoes (Plate 3, Fig. 11) were made in four sections, the side castings being 27 feet 5½ inches in length and the end castings 20 feet 4 inches in length. The cutting edge was of cast iron, 2 feet 1 inch in depth, with vertical wrought-iron straps riveted on by two 1-inch rivets. After the castings were received on the works, they were temporarily bolted together and the straps squared up, after which timber lining, or cleading, was fitted and bolted to the straps. The timber lining consisted of pitch pine planks, from 10 inches to 12 inches wide by 2½ inches thick laid longitudinally with vertical timbers at every strap, 10 inches wide by 2 inches thick. After the timber lining had been fitted on, the four sections of the shoe were taken apart and lowered by cranes on to the bed prepared for them, where they were carefully set. The castings were fastened together by three 1¾-inch bolts at each corner, and in addition to this, the side and end castings were joined by a sunk fish plate, 14 inches long by 3 inches wide by 1½ inch deep, riveted up with two 1½-inch rivets. The completed shoe was 6 feet high and 5 feet wide across the top, which was the width the walls of the monolith were to be built. The shoe having been set in position, bolted and riveted up and carefully levelled, was next filled with cement concrete (one part of cement to five parts of river gravel in which the proportion of sand to small stones was about 1¼ to 3¾). After this, standards and shutters were erected and the building of the side walls proceeded with, the shutters being chiefly 4 feet high, though in some cases they were 3 feet. After each filling of the shutters, sufficient time was given to allow the concrete to set, after which they were raised and another lift of concrete put in. The work was of course tidal, and care had to be taken that the setting concrete was not disturbed by the action of the rising tide, and at the commencement of each concreting, the previous work was washed over and roughened on the top. After the monolith had been built to a height of 18 feet, the standards were taken off, and when sufficient time had elapsed to allow the concrete to gain strength the kentledge blocks were put on and the monolith sunk, by the grab or otherwise, until the top was about six feet above low water, when the kentledge was removed, the standards and shutters reset, and the second building proceeded with. The kentledge blocks were cast-iron blocks, part

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being one ton each and the remainder two tons each, and had holes cast in the centre to take a lifting key, with special arrangement for fastening and releasing. The second building was about eleven feet six inches in height, making the depth of the monolith 29 feet 6 inches, and after this was completed the same process was again gone through and the monolith sunk a second time. The third, and final, building of 8 feet, making 37 feet 6 inches in all, was then carried out and the monolith finally sunk until the toe of the shoe had reached the depth required, which was from 33 feet to 35 feet below low water O.S.T. As the ultimate dredging level was to be 25 feet below low water, this meant that the monolith shoe would be 8 to 10 feet below this level. Two concrete mixers (Taylor's), one of half cubic yard and the other of one-third cubic yard capacity, were used in the concreting, both being electrically driven from 10-horse-power motors, and in addition hand labour was employed. The ½-yard mixer was of great service, and 60 to 70 cubic yards of concrete per day of nine hours could be passed through it, whilst the small mixer was capable of producing 35 to 45 cubic yards per day.

Monolith Sinking.

The most interesting and, at the same time, difficult part of the work was in sinking the monolith foundations. In monolith sinking on previous sections of the Quay works, the difficulties to contend with had been chiefly in keeping the monoliths to true line and level as the strata passed through was mainly sand and mud, and the monoliths were very liable to heel over and get out of line. This was guarded against by careful adjustment and readjustment of the kentledge blocks and by the excavation. Trouble was also experienced through inrushes of quicksand, which occurred if the monolith was obstructed in sinking and the excavation carried below the level of the cutting-edge. These difficulties were, however, overcome by careful working, and the rate of progress of the sinking was fairly rapid, it being a common thing to sink a monolith from 3 to 5 feet per day. In these cases the monolith sank as the sand was lifted out of the well by the grab-dredger, its own weight and the super-imposed kentledge being sufficient to accomplish this. On the present section a totally different type of sinking was encountered, and the rate of progress was necessarily much slower. After the first two or three feet a very hard clay was encountered, and

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the weights of the monoliths and kentledge combined were not sufficient to overcome the stiffness of the ground. The heaviest grab-dredgers used (Wild single chain grab-dredgers of 1 cubic yard capacity) made very little impression on the clay, and as the rate of sinking was extremely slow, it was found necessary to pump the water out of the well of the monolith when the tide was low and put men into the well to excavate and loosen the clay beneath the cutting edge. These men worked the whole time the water was clear of the monolith, and when the tide rose again and filled the well, the loosened clay, etc., was removed by means of the grab-dredgers. This was naturally slow work, as, when the monolith was built to its full height of 37 feet 6 inches, during the final sinking, the amount of water to be pumped out of the well was about 50,000 gallons, and this had to be done after the tide had fallen and uncovered the monolith, in certain positions, only allowing a few hours for fixing the pump, pumping out the water, excavating in the well, and removing the pump. Pumping out the water also assisted the sinking, 6 to 9 inches being frequently gained by the pumping alone, before other operations had commenced. After the first two or three monoliths had been sunk, the rate of sinking had been so slow, and the clay so extremely hard to excavate, even with the use of pumps and the men working in the wells, that it was deemed advisable to resort to blasting in order to loosen the stiff material. This process proved most successful and was employed in the sinking of most of the remaining monoliths. The method adopted was to pump all the water out of the well and then lower men down in a skip, who drilled holes from 2 feet to 2 feet 6 inches in depth at regular intervals, in the stiff clay below the monolith shoe. Small charges of gelignite were inserted in these holes with fuses of sufficient length to allow the men plenty of time to be lifted to the surface after igniting the fuses. These shots were fired singly, and by the time a series of charges had been exploded round the shoe, a large quantity of material was loosened and the monolith had generally sunk from one to two feet, and after the loosened material had been removed would at times sink further. Chiefly by means of this alternate pumping, blasting, and grab-dredging the monoliths were all sunk to a depth of about thirty-three feet below low water, the great proportion of the excavation being sent to sea in hoppers. The work of sinking was carried out continuously, night and day, the

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works being lighted at night by electric arc lamps. No great trouble was experienced in keeping the blocks in line and level, though in one or two cases in the first sinking they heeled over considerably, but were righted by the kentledge blocks and careful excavation. The greatest weight of kentledge placed on any monolith was 530 tons, and as the monolith and shoe weighed about 880 tons, there was a total sinking weight of 1410 tons. In spite of this, the skin friction of the clay on the sides of the monolith was so great, that even when the clay was excavated to 7 or 8 feet below the level of the cutting edge, the monolith would not sink until the water had been pumped out and explosives fired.

No. 3 monolith (Plate 1, Figs. 1 and 2) was the first sunk, and the work was then carried eastward, and afterwards, as the land was obtained, westward and up the Ouse Burn. The sinking was extremely hard from No. 3 eastward, but a change took place westward near the corner monolith (No. 1), and the sinking of the monoliths in the Ouse Burn and for the bridge foundations was very much easier, the clay being of a much softer nature. The six monoliths for the bridge foundations (D, E, F, G, H, I, Plate 1, Figs. 1 and 2) were carried down to depths of from 28 feet 2 inches to 31 feet 6 inches below low water O.S.T., which was nearly twice the depth originally intended, but the clay and silt passed through here were of too soft a nature to found on, as a very heavy weight of abutment and superstructure was supported by each monolith. However, a sound foundation was found at the depth mentioned and no movement in these or any of the monoliths afterwards took place. The pumps used in the sinking were a Cornish pump lifting from 20,000 to 25,000 gallons per hour and a Pulsometer pump lifting about 7000 gallons per hour. The cost of sinking of course varied according to the depth and the strata encountered, and the final sinking was naturally the most expensive. From 4*s.* 6*d.* to 5*s.* per cubic yard of excavation may be taken as a fair average of the cost, this including all charges and the removal of the material to sea. An average of 5*l.* 10*s.* per sinking foot per monolith would be a very near approximation to the cost.

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Diving and Well Filling.

After each monolith had been sunk to its permanent position divers were sent down, who removed any loose clay or material from under the curb and packed bags of concrete under the curb in any spaces that occurred. The bottom was also levelled up, after which the "hearting," or concrete filling, was put into the well. The concrete, composed of one part of cement to seven of river gravel, was lowered through the water in drop-bottomed skips containing from ½ to 1 cubic yard, care being taken to lower the skip slowly and evenly through the water to prevent the concrete being washed. When the skip had reached the bottom the doors were opened by means of a catch worked by a rope from the surface, and the skip gently raised to the surface, leaving the concrete deposited. The filling was kept as even as possible to prevent the cement running into hollows and forming soft deposits which would not set. When the filling was within two feet of the surface, the water was lifted out and the remainder of the hearting filled in from the top. The hearting deposited in this manner was found to be perfectly sound, and in a few cases, where low-water outlets for sewer diversions have been cut through monoliths filled in this manner, the concrete was found to be extremely good.

Keyways. (Plate 3, Figs. 8 and 9.)

The monoliths were spaced about 2 feet 9 inches apart, with a keyway in the end walls, and the spaces at the front and back afterwards closed by means of sheeting piles. The front piles were about 35 feet long and the back piles 30 feet long. These piles had to be very carefully driven to prevent material coming into the keyways during excavation. The spaces were cleared out by means of small grabs and by pumping out the water and excavating by hand, to a depth of 26 feet below low water, after which they were filled in the same manner as the wells, very small skips having to be used and the concrete being composed of one of cement to five of river gravel.

Quay Wall. (Plate 3, Figs. 8 and 10.)

After the monoliths and keyways had been filled the tops were dressed level and the first course of the ashlar wall set. The wall consisted of ashlar facing and concrete backing (one of cement to five of river gravel). The stone used in the wall

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was coarse-grained sandstone from local quarries, which had been found to wear well on previous works. The facework was diamond hammered, with a drafted margin 1 inch wide, and had a batter of 1 in 12. The facework was built in alternate headers and stretchers, the stones being of large size and the headers having a bond into the concrete of not less than 12 inches. The courses varied in depth from 1 foot 8 inches in the lower courses to 1 foot 5 inches in the top course. The wall was about eighteen feet six inches in height and 6 feet wide at the top and 8 feet 9 inches wide at the bottom. Fender straps, 3½ inches by ¾ inch, were built into the wall, being carried in about eighteen inches and turned down two inches. The fenders were originally intended to have been American rock elm, 13 inches by 13 inches square, and from 18 to 20 feet long, but on account of the high price of elm, American oak was substituted and appears to be lasting well. They were spaced 15 feet apart and fastened with six bolts, 1 inch diameter, through three pairs of straps. The wall was finished with a granite coping 4 feet by 1 foot 9 inches, the stones being jointed to allow a cement dowel 4 inches square and the full depth being afterwards run in. Fender steps of ¾ inch square iron were fixed in the fenders and hand-chains to the coping and mooring-rings of 2 inches diameter metal were fixed to the coping. The space behind the wall was filled with dry ashes and other suitable filling, and weep holes were left through the wall at intervals, rubble being built up at the inlet to each weep hole. As the filling was put in the timbers of the back stagings were gradually removed, but it was found not to be economical to draw the long piles, the heads of which were sawn off below the surface. These piles proved extremely useful in forming supports for the front of the shed which was afterwards erected.

Demolition of Old Buildings, etc.

The monolith sinking and wall building were, of course, carried out simultaneously, the wall following on as the monoliths were completed. Whilst this work was in progress the work of excavation and demolition of old buildings on the land behind, and the building of the heavy retaining wall and diversion of the road connecting the Quay and Burrell Road with the City Road, was also in progress.

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Interesting features in the removal of the old buildings, etc., were the removal of the old Glasshouse Bridge, which was blown down by gelignite, and a large chimney in the bottle works, about eighty-five feet high and very wide in the base, which was also removed by explosives. This chimney was in close proximity to the road and some works and offices in use, and it was therefore impossible to "fell" it in the usual manner. It was also considered unsafe to have men working on the chimney as it was very old, the base was founded on arches, and accidents might have occurred. It was therefore decided to "drop" the chimney direct, and for this purpose eight holes were drilled in the foundations of the arches, spaced equally distant, into each of which was inserted a charge of gelignite. These charges were furnished with electric detonators and fuses and electrically connected up, so that when the current was switched on the charges should explode simultaneously. This was done, the foundations were shattered, and the chimney dropped nearly vertically, no single brick falling without the boundary. The bricks were then removed from the works and excavation proceeded with.

A steel girder bridge about sixty feet span, and carrying two 30-inch water mains across the Ouse Burn, had also to be removed, and this was effected by erecting a staging on a barge, which was floated under the bridge and lifted by the rising tide until the superstructure of the bridge rested on the platform (the fastenings to the abutments having been removed), when the bridge was carried higher up the stream, where two temporary abutments had been prepared and, as the tide fell, deposited in its new position. It was there used as a temporary footbridge, to replace the old Glasshouse Bridge.

Low-Level Bridge over the Ouse Burn. (Plate 2, Fig. 4, and Plate 4, Figs. 12, 13, and 14.)

As previously stated, the Low-level Bridge was carried on six monoliths, each 22 feet by 15 feet. These monoliths were spaced 15 feet apart, and their walls were 3 feet 6 inches, as against 5 feet in the large monoliths. The shoes were of a lighter section than the large shoes, but of exactly similar pattern. After the monoliths were sunk and filled the abutments were built. The abutments were of dressed stone facework and concrete backing, as in the wall; but in this case the face had no

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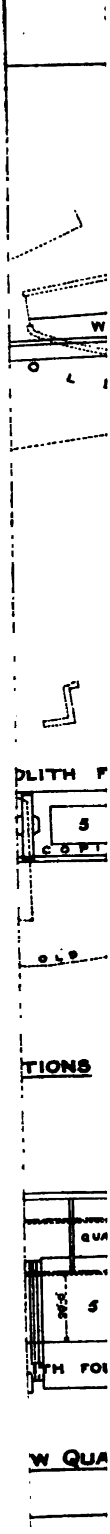

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batter. The spaces between the monoliths were arched over, the arches being semicircular and built of brickwork, five rings thick, in cement mortar, with ashlar voussoirs on the face. Behind the arches, concrete walls 4 feet 6 inches thick were carried down to about six feet below low water, to retain the ground at the back and the filling. The bedstones for the girders were of granite, and were about two feet deep. The superstructure (supplied and erected by the Cleveland Bridge and Engineering Company, Ltd.) consisted of three mild steel plate girders, 76 feet 6 inches long, with cross flooring of Hobson's patent troughing, 1 foot 3 inches deep and ½ inch thick. The centre girder was arched, and 8 feet 4 inches deep, and the side girders straight, and 7 feet 2¼ inches deep. The bearing plates were of cast steel, those on the west abutment being fixed, and on the east free to move on 8-inch diameter steel rollers. The troughing was filled and covered with concrete, and a damp course of rock asphalte mastic, ¾ inch thick, laid over the whole surface. On this the paving, consisting of 4-inch Aberdeen granite cubes, was laid. The southern half of the bridge carries a double railway track of standard gauge, and the northern half a 20-feet roadway and a 10-feet space, on which are carried two 30-inch diameter and one 12-inch diameter water pipes of the Newcastle and Gateshead Water Company, and one 7-inch gas pipe. The bridge was afterwards tested by means of four steam cranes travelling on the southern half and two steam rollers on the northern half. The total load was 132 tons 17 cwts., and the greatest deflection at the time of application of maximum load was one-fifth of an inch, there being no permanent deflection.

Railways, Roads, and Paving.

Approach roads on a gradient of 1 in 40 were formed to the bridge on either side of the Ouse Burn, small retaining walls being built to hold up the raised ground. A double railway track was laid, extending the railway on the west side across the bridge and the full length of the new wharf. The rails were of tramway section, 5½ inches deep, with 7-inch flange, and weighed 99 lbs. per yard. They were laid on pitch-pine longitudinal timbers, 11 inches wide by 5 inches deep, laid on a concrete bed. The railway and roadway were paved with 4-inch Aberdeen granite cubes, and a 3 feet 6 inch footway behind was made of concrete *in situ*, with a 12-inch by 6-inch granite kerb.

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Single Story Shed. (Plate 2, Figs. 4, 6, and 7.)

The erection of the single story transit shed, 240 feet in length by 70 feet wide, completed the work. This shed, erected by F. W. Cross & Co., Ltd., of Walsall at a cost of 2425*l.* 8*s.* 7*d.*, was built of steel columns and roof principals, with brick gables and panelling and steel framed sliding doors lined with corrugated iron sheeting. The door openings were 30 feet wide, three doors 14 feet 3½ inches deep and 10 feet wide to each opening, the doors being carried from above by means of 6-inch diameter steel wheels running on a half-round bar carried on steel channels. The roof was composed of galvanized corrugated iron, eighteen gauge, coated on the outside with two coats of bitumastic solution, and a glazed skylight extended along the centre of the roof. The floor was composed of 1½ inch of rock asphalte mastic, laid in two ¾-inch layers on a bed of concrete 8 inches thick. No grit was allowed in the lower layer, and about 20 per cent. in the upper layer. The shed was afterwards lighted both internally and externally with electric lamps.

Dredging and Removal of Staging.

On the completion of the works, the temporary staging in front of the newly constructed wall was removed. The decking, beams, wallings, etc., were first removed, after which the piles were drawn by a floating pile-drawing craft, or jib keel, belonging to the Tyne Improvement Commission. So firmly were many of these piles embedded that they were torn in half in the endeavour to draw them, leaving the lower portion still fast in the ground. These broken piles were afterwards removed when a portion of the dredging had loosened the clay around them. The berth was dredged for the Corporation by the Tyne Improvement Commission to a depth of 20 feet below low water O.S.T., 78,110 tons of material being dredged and sent to sea, the cost amounting to about 10¾*d.* per ton.

Plant.

The principal plant employed on the works included, one 7-ton crane (Smith, Rodley), two 5-ton, and one 2½-ton cranes (Stothert and Pitt, Bath), all being capable of travelling, slewing, and derricking; one 2½-ton fixed derrick crane, two pile frames with steam winches and boilers complete, three steam

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pumps, three 1 cubic yard grab-dredgers, two $\frac{1}{3}$ cubic yard grab-dredgers, diving pump and complete outfit for two divers, 530 tons of kentledge blocks, two Taylor's patent concrete mixers, two 10-horse-power motors, etc. A portion of this plant had been used on previous sections of quay works.

General.

The total amount of concrete in the monolith foundations amounted to 9904 cubic yards in the walls and keyways, and 5183 cubic yards in the wells. The concrete in walls cost about 11*s.* 9*d.* per cubic yard, and in wells, 8*s.* 6*d.* per cubic yard. These low costs were much assisted by the low price of materials, cement costing from 1*l.* 0*s.* 9*d.* to 1*l.* 6*s.* 6*d.* per ton, and river gravel and sand 1*s.* 8*d.* per ton alongside the works. The cement was of good quality, each lot being carefully tested and conformed in all respects to the British Standard Specification. With the exception of the steelwork of the bridge and the transit shed the whole of the work was carried out by the Corporation direct. The work was in every way successful, and though the scheme was considerably enlarged from the original design, was carried out within the estimate. It was found advisable to buy a greater area of land than originally intended, to make provision for the future, and for this there was a supplementary grant. The cost of the land purchased varied from 2*l.* 3*s.* 1*d.* to 5*l.* 13*s.* 8*d.* per yard (the latter figure including compensation for trade and buildings). The works were commenced in October, 1906, but the whole of the land required was not obtained till July, 1908. The foundation work and walls were completed in April, 1910, and the transit shed, railways, and paving in 1911. The works were carried out by the respective City Engineers, Mr. C. R. S. Kirkpatrick, M.Inst.C.E., and Mr. W. J. Steele, M.Inst.C.E. The author of this paper was Resident Engineer during the whole of the construction.

APPENDIX I.

Costs of Materials used on Works.

	£	s.	d.		£	s.	d.	
Castings for monolith shoes	6	2	6	to	6	7	0	per ton
Wrought-iron straps for shoes ..		10	6	to		12	0	per cwt.
Bolts, nuts, and rivets for shoes ..		13	0	to		17	0	,,
Steelwork in bridge girders					12	5	0	per ton

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	£	s.	d.		£	s.	d.	
Steelwork in Hobson's troughing ..					12	10	0	per ton
Steelwork in columns of shed ..					11	0	0	„
Steelwork in roof principals ..					12	0	0	„
Kentledge blocks (cast iron) ..					3	6	6	„
Cement	1	0	9	to	1	6	6	„
River gravel						1	8	„
Sand						1	8	„
Aberdeen granite cubes					1	8	4	„
Pitch pine piles, 50 to 55 feet long ..		2	1½	to		2	4	per cubic foot
Ashlar face-work for wall						1	8	„
Norwegian granite coping						2	4½	„
Norwegian granite bed stones ..						3	1	„
Asphalte damp course ¾ inch thick ..						3	6	per square yard
Asphalte floor to shed, 1½ inch thick ..						4	4	„
American oak fenders						4	5	per cubic foot

APPENDIX II.

Costs of Completed Work.

	£	s.	d.		£	s.	d.	
Castings, straps, bolts, etc., for one monolith shoe, 30 feet by 20 feet complete	144	10	10	to	151	4	10	
Concrete in walls						11	9	per cubic yard
Concrete in wells						8	6	„
Sinking		4	6	to		5	0	„
Dredging							10¾	per ton
Monolith foundation (complete)..					1	14	0	per cubic yard
Quay wall (complete)					1	12	0	„
Quay wall and monolith foundation (complete) about.. ..					170	0	0	per lin. yard

DISCUSSION.

Mr. Frank Massie: As Chairman of the North Eastern District it affords me pleasure in proposing a vote of thanks to Mr. Steele and Mr. Laws for the excellent papers which they have prepared. They have given to the Institution material which will be a credit to it, and most useful in after days. A hasty glance at the diagrams on the walls, as well as the most excellent copies we have of them attached to the papers, shows there is a good deal of work in the city engineer's department. The city of Newcastle must be progressing favourably, or else the Corporation could not undertake such large works as have

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evidently been constructed during the last ten or eleven years. Mr. Steele has called our attention to the smaller number of houses erected during the last thirty years, but he did not call your attention to the more satisfactory chart exhibited as to the value of the buildings erected, which shows that, although they do not build so large a number of houses, yet the estimated cost of the buildings they do put up appears to be increasing rather than decreasing, which is no doubt very satisfactory to the ratepayers of Newcastle-on-Tyne. For instance, in 1913 the estimated cost of the buildings exceeds 506,541*l.*, whereas the year before it was only 341,351*l.* In reading through the papers I was much interested in what Mr. Steele has to say as to town planning, particularly as to the reasons which he thinks would warrant intrusion into the area of an adjoining authority, and also the attitude which he is advising his Corporation to take up as regards the landowners in the area which he suggests should be town planned. Both these paragraphs are conciliatory in tone, and such as should lead generally to success. If all surveyors would approach the owners of land in the spirit of the two paragraphs it would save a good deal of trouble and probably a good deal of ill-feeling. I feel we are very much indebted to Mr. Laws for his paper. We can admire the work which he has done for the Corporation of Newcastle, and I hope we shall have an opportunity of a close inspection of it, as thereby it will be even more impressed upon our minds than by reading the excellent paper or through the inspection of the diagrams accompanying it.

MR. LESLIE ROSEVEARE: I have considerable pleasure in seconding the vote of thanks. Mr. Steele speaks of the progressiveness and foresight of Newcastle. It is not only in the present time that Newcastle had foresight, for I notice that in 1245 they started town planning by trying to prevent the growth of South Shields by limiting the number of houses to the acre to zero, apparently, however, without success, as at the present time there is a population of 112,000 there. Then in 1645 Newcastle said South Shields should have no quayage, so they were still trying to exercise their control over a large area. With reference to the quay work, the comparison of timber piles as against reinforced concrete is one which is interesting, especially to those of us who have to advise our Corporations on similar work. The information obtained by Mr. Steele, and

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some of the results I have seen lately, incline one to agree with the decision of the Newcastle Corporation to utilise timber for pile work under similar conditions. Then, as to the question of drainage, Mr. Steele has remarked upon the expenditure necessary to carry the sewer outfall to the sea. Like Newcastle, my Corporation has been approached as to doing something in the way of sewage treatment. It would, however, probably be cheaper to pay for the salmon alleged to be destroyed rather than to carry out such a scheme. As to the table of inclination of sewers, Mr. Steele has shed light on it when he says that it is computed so that the sewers shall be self-cleansing between the hours of 8 p.m. and 4 a.m. There is a considerable variation between the maximum and minimum allowances in this table, and it would appear that in certain instances the minimum inclination would be nothing like sufficient to deal with the rainfall, having regard to the fact that, with the sharp gradients prevalent in Newcastle, the time of concentration is so short. The whole thing revolves round the number of houses to be drained. Another factor is required, that is, the number of houses per acre upon which Mr. Steele has based the table. Without that it is impossible to gauge the likely discharge due to the rainfall, which is of course the serious factor in designing the size of the sewers. Mr. Steele has experimented on his chip paving. I admire his moderation in the description of chip paving. It is an abomination to a south country man, and it is only the hardy north countryman who would tolerate it in front of his residence without making a complaint, but if one were to suggest putting it down in the south such paving would cause an uproar. With regard to the question of flats, in certain parts of my borough laid out under the by-laws the owners manage to get 206 people to the acre, which in this age of town planning is, to say the least, not desirable. My Council has taken, under my advice, the same attitude as the Newcastle Corporation as to the advisability of going into the calculations for reinforced concrete buildings. This is very essential, not only to eliminate freak designs, but from the fact that reinforced concrete specialists are gradually increasing the stresses. They used to work to 435 lbs. pressure per square inch, but now it has gone up to the standard set by the Institute of British Architects of 600 lbs., and generally they seem to be running the margin of safety finer and finer. What I like in Mr. Steele's

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paper is the acceptance of responsibility—the old idea that the Corporation should dictate terms but accept no responsibility is, in my opinion, not correct. This accepting of moral responsibility—properly safeguarded—is in the right direction. The average building inspector, however, cannot be clerk of works for every job under his control. The design may be perfectly satisfactory, but it is absolutely essential in most buildings to have a test carried out afterwards, for any one who has had experience of reinforced concrete work knows it is not only a question of design but of workmanship afterwards, for in no class of construction is this more important. If the work is not properly done the soundness of the design is entirely counteracted. There has been a town planning conference in Newcastle this week, and I was much struck by one or two statements that town planning was not only best for the local authority but for the landowner. It was said in effect, "You need not worry at all—go into the question of town planning on proper lines, and the landowners will come to you, cap in hand, and welcome you with open arms." That is so different to the general experience of corporation officials that I should like to know Mr. Steele's experience. The including of certain lands outside the boundary of the authority in the area to be planned is a difficult point. The average man does not desire to have his land included in the area to be town planned. We are told that there are to be no details given to the landowner for the first stage. An owner asks, "What is a town plan?" The answer is to be, "Oh, a town plan is a town plan. We are limiting this area of land to so many houses per acre." The intimation to the Newcastle conference was that the average man was going to accept that. If I were a landowner I should not do so. I should like to ask also whether the Newcastle Corporation propose to make this town planning scheme pay for itself. It seems to me that if town planning is to be carried out on proper lines we shall not have to follow the example of Birmingham, who have started with spending 103,000*l.* on roads. That seems to be the wrong principle altogether, for if a Corporation has to put down over 100,000*l.* for the development of roads in a town planning scheme of 2300 acres it is a serious matter for small councils. If town planning is the best thing for the owner as well as for the local authority, surely it should be capable of development without any substantial grant from the

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local authority, except in cases where a road is required to be widened considerably—say to 100 feet—and then it may be necessary to pay a moiety of the cost of widening over a 50 or 60 feet road. I should like to know whether Newcastle intends to make its town planning self-supporting. Mr. Laws's paper is especially valuable in the detailed statements of costs. It is so rarely details of the cost of work are given in a way as to be a guide to one in works of a similar description.

MR. J. F. SMILLIE: I am constrained to make adverse comment upon one of the methods of disposing of house refuse which is adopted by the Newcastle Corporation. Mr. Steele, in his paper, tells us that no less than 35,000 tons of refuse annually are dumped into the sea, and I have reason to believe that this is the case. I think of all the reprehensible methods of getting rid of town refuse, with the exception of tipping it into disused quarries, this beats the lot. I know that after a storm at high water all along the beach at Tynemouth and Cullercoats there is a black line made up of old boots and other things which, in the interests of the inhabitants, have to be removed by the Corporation. I also know that bathers who go down to the beach for their morning dip return without entering the sea, because they are intimidated by the repulsive material which is lying about, and which they would have to pass to get into the water. It is time that an enlightened Corporation like Newcastle gave up so disgusting a practice. They are not the only riparian authority on the Tyne guilty of it, but as the leading authority on Tyneside they might show a better example. With regard to the table of Mr. Steele's of the size and inclination of sewers, I am not quite convinced of its infallibility. Putting down a sewer merely to carry off the drainage of a certain number of houses is quite satisfactory where there is a separate system of drainage, but I contend that the extent of the area to be drained is the important factor. If the sewer is sufficiently large to carry off a quarter of an inch of rainfall in an hour one need not worry very much. But if a 9-inch pipe is put down because 100 houses have to be drained, and those houses are spread over a comparatively large area, there is a chance of a flood taking place. A very important factor has been omitted in this calculation on the face of it. With regard to the work on the highways, I am in agreement with Mr. Steele that pitch-grouting is not so good in its results

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as laying down tar macadam. There is an indiscriminateness in pitch-grouting which is a very serious drawback to traffic. We have the gutters filled in wet weather with material which has been washed off the road, and this leads to a great loss of material and waste. My experience is that tar macadam properly mixed is in the end cheaper even than pitch-grouting. With regard to reinforced concrete, we must all admit that where reinforced concrete structures come under the purview of the surveyor they must be carefully watched. Whatever the design, they can all be falsified unless the workmanship is good. It is impossible for a town surveyor to keep under close observation all the work which goes on during building operations. My invariable rule is that, after the work is finished, it should be subject to satisfactory tests to show it is capable of doing the work it is intended for. That, in my opinion, is the only real safeguard for the public. In the early part of this paper Mr. Steele pays a very just tribute to the splendid achievements of the River Tyne Commissioners. There is no doubt about it that the prosperous development of Tyneside during the last sixty years is very largely due to the public spirit and enterprise which have been shown by that enlightened authority. It does occur to me that the interests of the various communities on Tyneside are so identified with the River Tyne, and so interdependent, so inseparable, that in matter of real fact they are one community with one interest, and I think the time will come when that fact will be generally recognised, it may perhaps be later rather than sooner, when the boundaries which now separate those districts will be regarded as anomalous and even ridiculous, and will be obliterated, and the whole district of Tyneside will be concentrated into one great municipality, free from the little parochial jealousies which too often prevail, and have prevailed in the past century between Newcastle and its neighbours. If it should become one great municipality, the people of Tyneside will be inspired with the welfare of the district and might well be proud to be citizens of a city which will then take a more honoured place among the cities of this empire.

Mr. G. Nelson: There was one point which struck me—that we are rather hard on chip paving. No one will contend at this time of day that it is an ideal paving, but it has done very well in the past and has answered its purpose, and now

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that, with improved conditions, it has to go into the background, I think we might let it down more easily than has been done. Ordinary tar macadam in side streets where they have an occasional carriage or milkcart answers the purpose quite well, but on main roads with heavier traffic tar-grouted macadam is a very good pavement. It is almost an ideal pavement where there is heavy traffic and where initial expenditure is a consideration. I am not able to comment on Mr. Laws's paper, but it has been very interesting to liston to.

Mr. J. S. Weir: There is only one question I wish to ask Mr. Steele, and that is why he does not put down whinstone sett paving. It is very much cheaper than granite, and, from experience I have ha l of it, is as good as granite. It is as durable, though it may be more slippery.

Dr. Kerr, Medical Officer of Health, Newcastle-on-Tyne: Might I suggest to Mr. Steele in his reply to state whether in giving the number of houses built he meant separate dwellings or separate buildings. In Newcastle we have large areas in which there are flats. Might I also suggest to Mr. Steele that as he has had such a large experience in the ventilation of sewers that he might give us some indication of his policy in Newcastle. It is a matter of great interest to myself and my Committee, as we perhaps have similar difficulties to deal with. The whole question of the ventilation of sewers is such a vexed one that an expression of opinion from Mr. Steele would be of advantage to us.

The President: Before putting the vote of thanks to Mr. Steele and Mr. Laws, I should like personally to express to them my keen appreciation of the trouble they have taken in preparing these papers. Mr. Steele has covered an enormous area, very typical of the work the municipal engineer has to undertake in these days, and has done it very concisely. To me it will always be a work of reference when I wish to see what important municipalities are capable of doing, and doing well. I notice you have a dual water supply. That, so far as I am aware, is not very usual nowadays. I know the same system exists in Paris, and those who attended our meeting there a year ago had some illustration of the difficulty of confining the use of trade water to trade purposes; and in that it seems to me there is an element, not of danger perhaps, but which requires very careful watching to safeguard the health of the

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people, and make sure they drink only the water they should. As to drainage how very fortunate Newcastle is as compared with our inland towns. The figures given of the cost of sewage disposal would make many towns jealous. I hope no great nuisance is caused by the discharge of the sewage into the River Tyne. If some day it becomes necessary to carry an outfall sewer to the sea, I hope all the municipalities on Tyneside will participate. The street lighting seems to be very cheaply done, and is another instance of the value of good, sound solid competition. With regard to the highways I am glad to hear that the use of Jarrah wood is satisfactory here, because I am told that soft wood is rapidly replacing the use of hard wood. It is satisfactory to find that in Newcastle where the traffic is very heavy, Australian hard woods still hold their own. With reference to pitch-grouted roads, I read that paragraph in the paper with great interest, and the discussion also appealed to me, because we have in Buckinghamshire—quite a rural district—been adopting both systems for some years now. I sympathise with those who have experienced difficulties with pitch grouting. I candidly confess that the pitch grouting which I have carried out has not given me satisfaction. It is not that the principle is unsound, but its application. We find the utmost difficulty in distributing equally our grouting; certain portions of the road are overcharged, others undercharged, so the wear is not even, and the road becomes very patchy indeed. But I have seen admirable results from pitch grouting. With tarred granite we have had very good results. You can tar the stone for anything from 5*s.* 6*d.* to 6*s.* 6*d.* per ton, which represents a matter of 8*d.* per yard super laid. That 8*d.* is money very well spent on provision for modern traffic. We have used also for the past nine years tarred slag on the heaviest used road in the county, the London and Bath road which has an enormous motor traffic, and the results have been very satisfactory. We are blessed now, or cursed, with a service of motor omnibuses—a half-hour service. We find that these motor omnibuses with heavy loads and small wheels, travelling at a rapid pace, are punishing the roads in a way no other traffic has done. They are not only wearing the surface of the road out, but compressing it, driving it into the foundation. The more you break the arch of a road, and compress it, the larger the openings of the joints of the road metal, and the more water gets into the subsoil which, as you

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know, is fatal to a road. With reference to chip paving, I have not been over a road of that kind recently, but in years past I have traversed some of the roads in Newcastle, and I think I remember them. One question that occurred to me was how, in facing or carpeting these old chip roads with tarred slag, Mr. Steele managed with his levels. Probably the old chip paving was very flat and allowed for raising in the middle, but how did it affect the channels? I am very interested to find, as the cinematograph official in my county, that the Corporation appoint an official to attend the performances. I am not required to do this. In the past Newcastle had prominent men like Mr. Grainger and Mr. Dobson forecasting the town planning system which we are now more or less forced to act upon. With regard to Mr. Laws's paper, I heartily congratulate him upon it. It is an admirable paper, which I have read with the greatest interest. I have not had to do any river or dock work, and the paper is an education in itself. It seems that the cylinder has been abandoned for the monolith. The reason is not given in the paper, but no doubt Mr. Laws will tell us why they have adopted the monolith. The whole secret of the strength of reinforced concrete is that you keep your steel absolutely watertight and airtight, for if you get any fractures you are starting a source of weakness that may have very serious consequences. I would like to ask Mr. Laws whether he was able to secure a complete alignment in his monolith. I would also like to know the weight of each, empty and charged. It is apparent that this construction is very massive indeed in the bulk, and I am very glad to find from the paper there has been no settlement of any kind. We shall have an opportunity of examining this work, and no doubt appreciating its excellent points.

The vote of thanks was accorded unanimously.

MR. W. J. STEELE, in reply: I am exceedingly obliged to you and all the Members for the vote of thanks you have been good enough to give to me. I am not at all surprised at the point raised by Mr. Roseveare and Mr. Smillie with regard to the size and inclination of the sewers. The point both gentlemen raised was a very pertinent one, because the number of houses to be drained is somewhat misleading, but it is done for a reason. The drainage area is based on fifteen houses to the acre, and the reason for giving the number of houses is that it

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is an easy method of calculation. We know under the present by-laws there would be something like fifteen to twenty houses per acre. I was impressed by Mr. Smillie's bold forecast of making the whole of the boroughs on the Tyne into one municipality. It is a question which does not want to be brushed lightly aside. He has raised the very important point as to whether it would not be better for the public as a whole to be governed by one municipality than as at present. I think it is a very bold view to put forward, and I hope it will not be lost sight of by the Members of our Councils. Mr. Roseveare raised a point as to letting landowners know the intentions of the Town Planning Committee. That is a point we have a great deal of trouble with. Some authorities take the view that the landowners should not be told what the Corporation have in view in town planning. It is, I think, a narrow view to take. If a man owns 40 or 50 or 100 acres, and you say to him, "We are going to town plan your land," he naturally asks, "What do you mean by town planning?" You say, "We are going to lay down the lines of new roads, and limit you to so many houses per acre." He says, "Where are you going to put the roads and the houses?" You simply say, "We are going to town plan, we will tell you that afterwards." If you tell a man to begin with what your general views are you may convert that possible opponent into a supporter. But if you do not tell him, very naturally you will have an opponent, because he does not know what your plans are. Now, with regard to a town planning scheme being self-supporting. Our Town Planning Committee's idea is that it should be self-supporting. The Committee's idea is that the Town Planning Act is intended to prevent the aggregating of houses, and to make a district more interesting and better to live in, but in doing that they do not think the authority should be saddled with any great cost. If the authority is going to be saddled with 100,000*l.* for 2000 acres of land, it is going to add enormously to the burdens of the ratepayer. That is not our view in Newcastle. There are a good many towns with a large agricultural area. If they are going to spend anything like 100,000*l.* for 2000 acres, the whole thing will drop; the ratepayers cannot stand it. Our view is that in planning a district the principal roads will be laid down, the width of the subsidiary roads fixed, the number of houses permissible defined, the general situation of factories, and the position and extent of

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public open spaces; when we have done that, we think we have carried out the spirit of the Act without undue interference with the ideas of the landowner in developing his own property. Mr. Smillie raised a point about the disposal of house refuse. Undoubtedly burning is the best way to get rid of it, but burning is a costly method. Our cheapest destructor costs 1*s*. 11*d*. per ton, inclusive of loan charges, whereas we can get it to sea for 1*s*. 7*d*. per ton. Then, when you burn the refuse, you have got the question—what is to be done with the clinker? If the clinker cannot be used on the Corporation's work or sold, there is the cost of haulage and tips to be added to the burning charges. I quite agree that it is a questionable method to discharge it into the sea, but we have not yet discovered how to make money out of refuse, and until that day arrives, we shall continue to tip a portion into the sea. Mr. Weir has raised a point as to why whinstone paving is not used instead of granite. We find that whinstone setts are slippery. It is possible to get a better dressed sett and to pave closer with whinstone than with granite setts, and further, whinstone setts are cheaper than granite in Newcastle; but, however good a pavement may be in other respects, if it is a danger or nuisance to the user, it should not be laid. In reply to Dr. Kerr's question, we have counted each slab as a house; that is to say where you have a building divided into two dwellings it is counted as two houses. With regard to sewer ventilation, there is probably no question which has been discussed more at the meetings of this Institution, than sewer ventilation; indeed it has been discussed *ad nauseam*. The present practice in Newcastle is to investigate each case of complaint of smell from a manhole which is surmounted by an open cover. If it is found that the air in the sewer will not be under pressure during heavy rainfalls, the cover is sealed down, or a closed cover is fitted to the manhole. We do not put up any air-shafts. In the report of the Departmental Committee of the Local Government Board on intercepting traps or house drains, it is shown that before any air can escape through the water in a trap, the head of water in a sewer above its normal flow must be greater than the head in the trap (or twice the depth of the water seal of the trap), and even then, air will not be forced through the water in the trap, unless the sewers are airtight. As to the President's remarks as to two supplies of water. I admit it is unusual, but there is no trouble in

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Newcastle. The trade mains have only been in use for about twenty years, and those mains are well known, and connections are only allowed to be made for trade purposes. With regard to the levels where the old chip paving is covered with tar macadam; when there is a depth of, say, 4 inches from the top of the kerb to the channel, this depth is decreased to about 1½ inch.

Mr. Hubert Laws: I thank you very much for the very kind vote of thanks you have given me for this paper. Mr Roseveare was interested in the keeping of the costs; I can assure him that they entailed a considerable amount of work. A careful analysis was taken each week, and the work apportioned a man doing nothing else; but these costs have been exceedingly useful since, in estimates for other works. They are actual figures and not estimates. The President has asked why the construction was altered from a cylinder to a monolith quay. I might refer him to a paper read by my predecessor, Mr. Scott. The first section of the cylinder quay walls was recommended by Mr. Jas. Abernethy and Mr. T. E. Harrison, Past Presidents Inst.C.E., and consisted of two rows of cylinders, 5 feet in diameter, 25 feet apart, with an arch thrown over, so it was not a continuous cylinder quay. After the Commissioners increased their dredging, this structure was not found strong enough. The costs were not so expensive, the quays averaging from 125*l*. per yard run. The next type of quay was the cylinders in close line. That was a very strong quay, and could be dredged to 25 feet below low water ordinary spring tides. The cost of this cylinder quay amounted to about 220*l*. per lineal yard. My uncle, the late Mr. W. Geo. Laws, and the late Mr. P. J. Messent, were asked to make a report in 1888, and after visiting several quay works, where they had the monolith quay, they recommended that construction as being cheaper, but quite as strong and capable of being dredged to the required depth of 25 feet. This construction was very strong, and has proved very successful. The weight of the monolith empty and the shot is about eight hundred and eighty tons, the filling amounts to 500 tons, and the weight of the completed monolith about one thousand three hundred to one thousand four hundred tons. As to the alignment, we did not get the monoliths in an exact line, but quite near enough for our purpose. The quay wall is in a perfect line. Once the monolith had entered into the clay we could keep it well in line. Some monoliths came slightly forward,

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but none came too far forward. We had no settlements. We had to go through a tremendously heavy clay, which would have been a splendid foundation, but it was impossible to stop there, because the dredging afterwards would have carried the foundation away. At Ouseburn the strata was a very good one, and the foundation excellent.

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CITY AND COUNTY OF NEWCASTLE-UPON-TYNE. OUSEBURN VALLEY WORKS.

BY FRANK I. MORGAN, ASSOC.M.INST.C.E.

SYNOPSIS.

Introductory—Necessity for Scheme—Powers obtained under Act of Parliament—General description of Scheme—Modified Scheme—Ferro-Concrete Culvert—Ouseburn Drainage Area—Rainfall Calculations—Area of Culvert to deal with Flood Waters—Carrying Main Outfall Sewer through Culvert—Discharge of Culvert—Experiments to Ascertain Load to be borne by Structure—Design of Culvert—Details of Reinforcement—Method of Construction—Working Stresses—Steel Tests—Cement Tests—Concrete—Proportions—Mixing—Concrete Tests—Loading Test applied to Culvert—Tables.

THE City of Newcastle was at one time intersected by quite a number of small Denes, running, through what is now the centre of the town, down to the River Tyne. The increasing expansion of the city from year to year rendered necessary the filling up of many of these, and their ultimate conversion into building land and streets—some of the principal thoroughfares and buildings in the centre of the city to-day stand upon the site of these valleys. By far the largest of them, however, and which is the subject of this paper, still remains to be dealt with, as for some time past its existence has constituted a serious obstacle to the efficient working of the traffic between the eastern and western portions of the city.

The eastern areas known as Byker and Heaton are divided from the western part of the city by a steep and wide valley, called the "Ouseburn Valley," at the bottom of which the "Ouse Burn" stream flows to the River Tyne. The only direct means of communication between the city and these suburbs is by a brick viaduct, called the "Byker Bridge," which crosses the valley at a height of about 120 feet above stream surface. This was built by a private company in the year 1877 and owned by them until the year 1895, during which period tolls were levied for crossing the bridge. In the year 1895 the

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Corporation acquired the bridge from the company at a cost of 120,000*l*. and freed it to the public.

During later years, however, the expansion of the city on its eastern boundary has been so rapid as to render the existing structure altogether inadequate to accommodate the requirements of the traffic, and when the extension of the city tramways to the eastern areas was decided upon it became necessary to widen the bridge to make room for these. The City Council recognised, however, that this would be but a temporary measure, and that they would, at no distant date, have to provide additional facilities for the growing traffic needs. Bearing this in mind, they took powers in the Newcastle-upon-Tyne Tramways and Improvement Act of 1899 to construct a viaduct over the valley at an estimated cost of 100,000*l*. From this date the matter was under constant consideration, and in the year 1900 the Council passed a resolution requesting the Town Improvement and Streets Committee to consider the propriety of filling up the Ouseburn Valley, or, in the alternative, a part thereof. Acting upon the Council's instructions, the committee gave careful consideration to the subject, and after exhaustive inquiry, reported to the Council in 1903 in favour of carrying out the filling scheme, which would enable the Corporation to provide ample means of communication between the portions of the City east and west of the Ouseburn, without entailing a heavy expenditure upon the ratepayers. This scheme they considered would be much more economical than the building of a viaduct in accordance with the powers obtained in 1899. The cost of acquiring the land, culverting the "Ouseburn," the making of roads and all other works in connection with the scheme, was estimated at about 161,000*l*., and to meet such expenditure it was estimated there would be a considerable revenue derived from payment for permission to tip material, and from rent of properties to be acquired, but which would not be pulled down until such time as their site was required to be raised to the new levels. In addition there would ultimately be a large area of land available for buildings in a populous part of the city. The Council, after full discussion of the above recommendations, decided to proceed with the scheme, and in the Newcastle-upon-Tyne Corporation Act, 1904, obtained powers which comprised the following works (see Plates, Nos. 1 and 2):—

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Works Nos. 1, 2, *and* 3 include the making of three main thoroughfares, 60 feet wide, across the valley at intervals from east to west, as shown on Plate No. 1.

Work No. 4 was for the construction of a culvert for enclosing, straightening, and diversion of the Ouseburn stream—the culvert, if required by the Tyne Improvement Commissioners, was to be constructed of such strength, and with foundations of such depth, at its lower or southern extremity, as would allow, without damage to itself, of such dredging in or deepening of the stream immediately to the south of the culvert as might be necessary for providing there a depth of 15 feet of water at H.W.O.S.T.

The total depth of the filling, from the bottom of the valley to the proposed new surface level, is about 100 feet. The greatest approximate width of the valley at the top is about 1200 feet and the minimum 550 feet. The estimated total quantity of filling required for the whole scheme is about 4½ million cubic yards. The method of procedure was to concentrate all efforts towards tipping one of the main arteries across the valley as quickly as possible, so as to give the much needed traffic facilities with the minimum of delay, and afterwards, as the filling became available, to gradually fill up the remainder of the valley and form the other main thoroughfares.

Reinforced Concrete Culvert.—In 1906 a commencement was made with the culvert, for enclosing the waters of the "Ouseburn," to keep its course free and unimpeded, after the valley had been filled in. This culvert had to be made of sufficient capacity to deal with the flow of the stream at its highest flood. Although a comparatively small stream in dry weather, it is liable to sudden floods, and in winter time assumes the proportions of a fair-sized river. The drainage area of the "Ouseburn" is 25 square miles, and after taking into consideration the conditions prevailing, and the volume that might be expected through the culvert in a heavy flood; also the probability of having to deal with cumbersome floating debris, and awkward obstacles, which might block the mouth of the culvert, and cause serious obstruction to the flow; it was decided to make ample provision, and design the culvert to take a 1-inch rainfall per hour, over the whole of the catchment area of 25 square miles. This necessitated a cross sectional area of 477 square feet, with a gradient of 1 in 141 and a discharging capacity of 964,800 cubic feet per minute,

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running full. Apart from the question of capacity, the design of the culvert had to be governed by the necessity for adopting materials, and methods of construction, that would be capable of withstanding the severe strains due to unequal loading, which would in all probability ensue during the process of filling up the valley. After careful consideration of the various factors, it was decided to adopt a reinforced concrete form of construction as being the best calculated to comply with the required conditions of the case, and the Hennebique system was chosen. This method of construction was also, from the point of view of cost, considered to be more economical. The culvert follows the windings of the valley in a tortuous line, the total length provided for in the original scheme being 2060 feet.

The invert level at the outlet end, close to the Ouseburn viaduct of the North Eastern Railway, was kept up about two feet above H.W.O.S.T., to give the culvert a free discharge at all states of the tide. Plate No. 3 is a typical cross-section of the culvert, which is in the form of a semi-parabola, and was adopted as being the best suited to resist the unequal earth loads anticipated during the operations of filling-in. The invert joins the parabola with a curve of 4 feet 9 inches radius, and its centre portion is paved with sandstone grit penning, to provide a summer channel for the river during the season of dry-weather flow. The maximum internal dimensions of the structure are, 30 feet wide at springing, and 20 feet high, with an over-all width across its base of 42 feet. The thickness at the crown is 8 inches, and at the springing, 14 inches. The base is reinforced horizontally with mild steel bars, for withstanding tension, and vertical stirrups for resisting the shear. The arch is reinforced by two series of main-bars, following the inner and outer curves of the parabola, and securely anchored in the invert; sufficient vertical stirrups are also provided for resisting the shear stresses. Additional reinforcement is provided throughout the structure by longitudinal bars, at short intervals apart, placed near the inner and outer surface of the concrete. This arrangement gives a double system of reinforcement, of sufficient strength to withstand any tension that may be developed near either surface of the concrete.

Foundations.—To enable the contractor to proceed with the excavations for the foundations, it was necessary to divert the stream. The dry-weather flow was deflected, by means of

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temporary dams, into existing sewers running through the valley, and auxiliary channels were provided for dealing with small rainfalls, by means of troughing laid along the bottom of the valley. It was impossible, however, to provide against heavy floods, which, when they came, necessitated suspension of the work. Borings were taken along the line of the culvert, to ascertain the nature of the foundations, but as is often the case, they gave no true indication of what was eventually met with in the course of the excavations. After the works had commenced, it soon became apparent that considerable difficulties were to be encountered. Large pockets of silt deposit were discovered at intervals, some of them extending the whole width of the foundations, and reaching to considerable depths before the shale bed proper was touched. In addition, old disused coal workings were discovered, crossing and recrossing the valley in all directions, some of them of formidable dimensions. In each instance, the unstable ground was excavated and the old workings thoroughly explored for some distance on each side of the foundations, and the whole filled in solid with concrete in mass. Great attention was paid to the putting in of these foundations, and every precaution taken to ensure a thoroughly reliable bottom, in view of the great weight of the filling that would ultimately come upon the culvert. In the construction of these foundations, about 28,000 cubic yards of material was excavated and about 9000 cubic yards of cement concrete were used. Details of the construction of the superstructure will be dealt with later. After the works had been in progress about two years, and the whole of the land and properties for the scheme acquired, it was found that the cost of these latter had exceeded the amount provided in the original estimate; moreover, the quantity of material tipped was not sufficient to ensure the filling of the valley in a reasonable period of time. The comparatively small quantity of material received, was undoubtedly due to the marked lull in building operations in the district. Owing to these circumstances, the construction of the culvert was temporarily stopped and a general review of the conditions was made. After considering reports by the then City Engineer, Mr. C. R. S. Kirkpatrick, M.Inst.C.E., the Council decided in 1909, to adopt a partial filling scheme, or a modification of the original. This was to continue their efforts to concentrate the tipping in the centre of the valley, and gradually to fill up in a northerly direction, so as to form two main arteries

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across, viz. Work No. 2, between Rosedale Street and Warwick Street, and Work No. 1, between Starbeck Avenue and Newington Road; these two roads being slightly altered in direction. For this purpose they decided to continue the culvert works for another 800 or 900 feet. The approximate total gross cost of the scheme, including expenditure upon land, sewers, retaining walls, culvert, main thoroughfares, and subsidiary streets, is 226,500*l.* When the reclaimed land is built upon, however, there will be a considerable revenue derived from this, in addition to that obtained from properties which may not be pulled down. The amount required to complete the work, *i.e.* the difference between the sum already borrowed, viz. 161,000*l.*, and the above total, was 65,500*l.* In 1910, the Council applied to the Local Government Board for a Provisional Order, so as to provide borrowing powers for this sum, and to amend the 1904 Act, as might be desirable.

This was granted by the Board, and arrangements were made for proceeding with the scheme. Estimates of time must necessarily be approximate, but it is hoped to be able to tip the embankment for Work No. 2, to obtain a road 20 feet in width in about five years, and a road of the full width of 60 feet in about eleven years. The high level area to the north, including the embankment for Work No. 1, it is anticipated will be tipped in a further period of about fifteen years; an improvement in the building trade will undoubtedly shorten these periods. When the scheme is completed as above, there will be two main arteries across the valley, and the available area for building land and streets, will be divided somewhat as follows:—

	Square yards.
Two main roads	10,700
Subsidiary streets	14,600
Building sites	81,600
Slopes of embankment and bed of Ouseburn	68,500
Low-level area, including streets	40,000
Existing buildings and streets within area previously dealt with, but which will not be demolished under the partial filling scheme	16,600
Total	182,000

The approximate quantity of filling required for the amended scheme, is 1¾ million cubic yards, as against 4½ million cubic yards, for the original scheme. Before proceeding with the

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extension of the culvert, the City Engineer (Mr. W. J. Steele, M.Inst.C.E.) considered the advisability of reducing its sectional area, and for this purpose rainfall calculations and other data, for determining the size of the structure, were investigated, as follows:—

The catchment area of the Ouseburn is 16,295 acres; the highest portions are about four hundred feet above ordnance datum, and the lowest about thirty feet (in the valley adjoining the existing invert), but generally, with the exception of Jesmond Dene, the catchment area consists of gentle slopes to the stream. From information collected over a long period of years, the greatest flooding in the Ouseburn Valley appears to have been in October, 1900. Careful records of this, and the rainfall which caused it, were made; between 9 a.m., on the 26th, and 9 a.m., on October 27, the quantity of rainfall registered was:—

	Inches.
Wellbourne, Jesmond	3·72
Leazes Park	3·24
Newcastle Chronicle Office	3·68

The flood heights were marked on the various bridges along the course of the stream. At the Dene Bridge, near Craghall Dene, there is a weir placed between the abutments, and this formed an excellent means of gauging the discharge at this point. With the depth of water passing over the sill, given by the highest flood marks, and a velocity of approach of 6 miles per hour, the discharge was 124,000 cubic feet per minute. In considering the capacity of a culvert which would discharge the whole of the flood water draining to the Ouseburn, it was necessary to note that the conditions applying to a main sewer draining an urban area were not the same as would apply to the culvert. In the case of a sewer, it is the intensity of rain falling in a short period that has to be provided for; as, owing to the large proportion of impervious surface in an urban area, not only is the percentage of the total rainfall reaching the sewer comparatively high, but it arrives in a very short time. With the culvert, however, the whole of the area drained would remain more or less pervious, until it became water-logged by continuous rain, and owing to the long period that would elapse before the rainfall reached the culvert, the volume, due to an intensely heavy fall in a short period, would become so dissipated as to give a comparatively low discharge. The basis of calculation

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was, therefore, taken to be the greatest continuous rainfall likely to occur over a period which such rainfall would take to reach the culvert—after the whole of the catchment area had become water-logged. To arrive at this period, tests of the velocity of the stream were made, and it was decided to adopt 2½ hours as the period which the rainfall would take to reach the culvert. A rainfall of 0·75 inch in 2½ hours was provided for, which is equivalent to 7·2 inches per day. With this provision, the volume to be carried by the culvert would be 295,754 cubic feet per minute. When completed, the culvert will have a fall of about thirty-seven feet per mile, whereas the stream—over the greater part of its length—has a fall of only about twenty-five feet per mile; also, the culvert will have a smooth surface, whilst the bed of the burn is rough, with numerous obstacles; consequently, the velocity of the stream through the culvert will be much greater than at any other point in its length.

Provision had also to be made in the culvert for carrying a main outfall sewer through it. There are two sewers in the valley, one on either side of the stream. The sewer on the west forms the outfall for the sewage of Gosforth, and part of Long Benton, within the Ouseburn drainage area, and that on the east drains a portion of Byker and Heaton. When the valley is wholly filled in, the sewers will have to be entered by manholes of great depth, and having regard to the uncertainty of the stability of the sewers to withstand the great weight caused by the filling in of the valley, it was considered advisable that they should be connected at a point above the inlet of the culvert, and carried down in one sewer through the same. In estimating the size of this sewer, the ultimate needs of the various districts within the drainage area, when fully built upon, were provided for, together with a five times dilution for rainfall, all excess storm water being taken to the "Ouse Burn." This necessitates a sewer 6 feet in diameter, which will occupy an area within the culvert of 50 square feet. It is not proposed to construct the sewer at present, owing to the long period that must elapse before the valley is filled in, but it was thought advisable to make provision for it, in fixing the size of the culvert.

Having regard to the high velocity that would be attained in a culvert of such large size, if allowed to run full, and to the excessive friction that would be set up over the walls of the structure, resulting in probable damage to the surface, it was

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decided to provide a liberal margin of safety to meet such contingencies. The gross cross-sectional area of the culvert was, therefore, fixed at 304 square feet; this is inclusive of the area required for the 6-feet-diameter sewer at some future date. Steel hangers are being built into the wall of the culvert as the work proceeds, to save any future cutting into the structure; steel bars will be threaded through these projecting links at a later date, around which the reinforcement for the sewer will be hung, and fixed as shown on Plate No. 4. The discharging capacity of the culvert, running full, is 525,180 cubic feet per minute, and when the proposed 6-foot sewer is built inside it will have a nett discharging capacity of 408,654 feet per minute, which is much greater than that required by the calculated discharge from the catchment area. Under such conditions, the culvert, when discharging its maximum calculated volume, will only be running three-quarters full. Plate No. 4 shows a typical cross-section of the reduced culvert, also the details of the junction between it and the larger culvert. The maximum internal dimensions are 24 feet at springing by 15 feet 6 inches high, with an over-all width across its base of 34 feet 8 inches. The same arrangement of reinforcement as was adopted for the larger culvert has also been preserved throughout the extension.

Experiments for ascertaining extent of load to be sustained by the Culvert.—With a view to arriving at some practical basis as to what proportion of the filling would become effective on the culvert, a model of a section of the valley one-sixteenth full size was constructed, which represented a width across the top of 354 feet, with side slopes 1½ to 1, and a total height of 80 feet of filling above the crown of the culvert; over and above this, the depth of the filling was increased to represent an equivalent distributed load of 7 cwts. per square foot. One end was glazed, so that the behaviour of the material during the test could be observed. The model was filled with ordinary excavated material, free from clayey or other substances tending to increase its adhesion, and representing, as far as possible, an average sample of the filling that would be likely to be tipped during the process of filling in. It was allowed to remain for a period of twenty-eight days, when the culvert was slowly lowered from the model, thus leaving the material free to fall out. Only a small quantity fell out with the culvert, the majority being retained in the model, by reason of its having become arched on the

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under side, and rendered self-supporting, thus demonstrating the principle that arching is set up in deep embankments when the material has become sufficiently consolidated, and that there is a point above the structure, where the filling becomes self-supporting. The height of this point from the experiment was found to be equivalent to 4 feet 8 inches at the moment the culvert was removed. The model was allowed to stand for a further period of six days, during which time further material fell out, representing a total height of 16 feet, or a load of 1 ton per square foot over the culvert base. At this period an additional super load was placed upon the model to represent a heavy rolling load, and equivalent to 1·21 tons per square foot. This was allowed to remain for twenty-one days, at the end of which time no further material had fallen out.

As a result of the above experiment, it was decided to design the culvert to support 40 feet of filling above the crown of the arch, which provided for a factor of safety of 2½. Details of the model and cross-sections of the arching in the filling, together with an average cross-section, are shown on Plate No. 5.

Loading Test applied to the existing Culvert.—On the strength of the foregoing, it was decided to apply the results obtained as a test load upon the existing culvert. The curve of the earth arching given by the experiment, was enlarged to 2½ times, representing a height of 40 feet above the culvert. This gave the resultant load to be borne by the culvert of 3 tons per square foot. A test load equal to 3 tons per square foot was therefore placed upon the existing culvert, as shown in Plate No. 6. As this test proved entirely satisfactory, it was decided to use the same section of reinforcement for the proposed extension as was used in the existing structure; likewise to adopt the same thickness of arch ring at the springing and the crown. As the extension is of smaller area than the existing structure, it would therefore be given an additional factor of safety.

Notwithstanding the above results, however, the Local Government Board, upon consideration of the scheme submitted to them, required provision to be made in the design of the structure for a total height of 80 feet of filling becoming effective upon the culvert. This necessitated a thickness at the crown of 10 inches, and at the springing of 16 inches, together with a much heavier percentage of reinforcement than was used for the preceding section. A commencement was made with

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the extension in 1912. The length included in the present contract is 820 feet.

Method of Construction.—This is briefly as follows: The reinforced invert is first put in upon foundations already prepared, and temporary longitudinal sills are fixed in position on each side at the benching level; upon these the centring ribs for the arch are erected at distances of from 3 feet to 4 feet apart. These ribs are constructed in two portions, and blocked out from each other at the crown, so that upon completion of the arch they can be slackened and drawn together, thus facilitating the process of removal when the time arrives for taking the centres out. After the ribs are in position the lagging boards are placed on top and securely fixed, thus completing the inner drum of the parabola. Next, the curved intrados bars are placed in position on the drum and blocked out to their correct distances from the face of the concrete: for this purpose, cement blocks are used, which ensure the bars receiving their proper amount of cover. The external bars are next fixed in the same manner, and the spaces between the two sets temporarily preserved by boards placed on edge longitudinally, in convenient positions. The external ribs are next fixed in position, to correspond with the internal ones—the inside faces of these frames form the profile of the extrados of the culvert, and to these the outside shuttering is fixed, as the concreting proceeds. Thus a complete mould is formed, the exact shape of the parabola, into which the concrete is placed and thoroughly rammed between and around the bars of the reinforcement. All laps in the main bars are made at the crown of the arch.

The culvert is constructed in 30 feet lengths, and straight joints are made at these distances. Where a fresh length is joined on to an old one, the surface of the set concrete is thoroughly hacked and roughened and covered with thick cement grout; afterwards the new concrete is firmly rammed against the old. The period of rest allowed for the centres before removal varies according to circumstances and the weather; in no case, however, are any centres struck under ten days, and from this the periods vary up to three weeks. The culvert, for the greater part of its length, is on curves of 312 feet radius, and this necessitates considerable care being observed in the construction of the centring and falsework.

Bending of Bars.—Substantial staging is laid down, upon

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which a full-sized section of the culvert is set out. Steel pins are inserted at intervals along the intrados and extrados of the arch and invert, and around these the bars are strained and bent to their respective shapes. The bars show little tendency to revert to their original shape after being bent, and when placed in position in the work are found to fit very satisfactorily.

Working Stresses.—The working stresses used in the calculations for the culvert were as follows:—

Concrete in compression	355 lbs. per square inch.
„ shear	60 „ „ „
„ tension	Nil.
Steel in compression	17,000 „ „ „
„ shear	12,880 „ „ „
„ tension	17,000 „ „ „

Steel for Reinforcement.—The steel used is in the form of round bars and strip, manufactured by the Open Hearth or Basic process. Periodical tests of the material gave average results, as follows:—

Contraction of area	about 56 per cent.
Elongation in 8 inches	„ 29 per cent.
Limit of elasticity	20 tons per square inch.
Ultimate tensile strength	29·6 tons per square inch.

Expansion Joints.—The advisability of providing expansion joints was carefully considered, but as the structure will be buried upon completion it will not, of course, be affected, to any appreciable extent, by temperature. The only way in which it is likely to be affected will be by the change in the temperature of the water flowing through it in different seasons, but this was considered to be so slight as not to warrant provision being made for it. As an extra precaution, however, to ensure water-tightness at the straight joints, bands of pure bitumen are being placed over each joint around the extrados of the arch, so that in the event of any slight cracks occurring at these points it will preclude any moisture leaking through and affecting the steel.

Cement.—The cement used throughout the work conformed, as to preparation, quality, and chemical composition, with the British Standard Specification, with slight modifications as to grinding and setting time. The fineness of grinding is 15 per cent. by weight left on a sieve of 32,400 meshes to the square inch. Each consignment brought to the works is thoroughly

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tested, and the results of the whole average as follows:—Initial set, 59 minutes; final set, six hours; expansion at one day's aeration, three millimetres; specific gravity, 3·12; ultimate tensile strength at seven days, 553 lbs. per square inch, and at 28 days 674 lbs. per square inch.

Concrete.—The aggregate used for the concrete consists of river ballast, obtained from the Tyne at Newburn. The ballast is put into the crusher and the sand separated by passing it over a rotary screen with $\frac{1}{4}$-inch square mesh. The larger stones in the ballast are at the same time broken to the required size, and everything from $\frac{1}{4}$ inch to $\frac{3}{4}$ inch is passed through a $\frac{3}{4}$-inch screen. Thus the sand consists of a mixture of coarse and fine grains from $\frac{1}{4}$ inch downwards, and the aggregate, of assorted sizes, not less than $\frac{1}{4}$ inch nor more than $\frac{3}{4}$ inch gauge. Afterwards the sand is added in true proportions. The concrete is mixed in the following proportions:—$7\frac{1}{2}$ cubic feet of aggregate, $3\frac{3}{4}$ cubic feet of sand, 2 cwts. of cement. The quantities for each mixing are accurately gauged, and careful supervision is exercised over this operation during the progress of the work. The consistency of the concrete is kept such as to give a plastic mixture, capable of being easily worked and rammed between all the bars of the reinforcement. It is machine mixed throughout, the sizes of the mixings being kept small to ensure the material being used quickly, in order to avoid loss of setting properties and strength. Frequent tests of the voids in the aggregate and sand are made to ensure that the proper proportioning of the mixture is being maintained.

Four-inch cubes of the actual concrete used in the works were made and tested (Nos. 1 to 12 inclusive in Table IV.). At three months old these crushed at an average of 2432 lbs. per square inch, giving a factor of safety of 6·85. Cubes of concrete of other proportions were also made and broken. The results of some of these at one month are given in Table IV. Concurrently with the cubes in Table IV., briquettes of cement concrete (one inch sectional area) were made of the same proportions and ages respectively, and tested for tensile strength—the results as far as obtained to date are given in Table V. Tests of the concrete made of the contract proportions were conducted on briquettes of 1 inch sectional area for tensile strength, and the results are given in Table III. Pieces of concrete of varying ages were cut out of the actual culvert and subjected to tests

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for specific gravity, absorption, and friability. A representative selection of the constituent parts of the aggregate contained in the river ballast was made and subjected to tests to ascertain its suitability for the purpose for which it is being used; the results given in the tables show that a good and durable aggregate is being obtained. Other tables are also appended, which it is hoped will be found of interest.

The Author's acknowledgments and thanks are due to Mr. W. J. Steele, M.Inst.C.E. (City Engineer), for permission to write this paper; Mr. Laurence E. Greening, Stud.Inst.C.E., for assistance in conducting the tests and preparation of the tables; and Mr. H. E. Lightfoot, for his assistance in the preparation of the drawings.

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TABLE I.—TESTS FOR ABSORPTION AND SPECIFIC GRAVITY OF THE CONSTITUENT PARTS OF THE RIVER BALLAST USED FOR CONCRETING.

Date of Test.	Number of Test.	Constituent Parts.	Weight of Specimen (grammes.)	Specific Gravity.	Calculated weight per cubic foot. (lbs.)	Absorption Test at 24 hours.	Hydrochloric Acid Test at 7 days.		Remarks.
						Percentage of Absorption.	Percentage of Absorption.	Percentage loss of Weight.	
Dec. 9, 1912	1	Blue Whinstone (hard)	287	2·73	171	0·69	nil	0·70	
Dec. 9, 1912	2	Sandstone Grit (fine grained)	617	2·33	146	2·10	2·59	nil	
Dec. 9. 1912	3	Sandstone Grit (coarse)	625	2·32	145	2·72	3·53	nil	
Dec. 9, 1912	4	Blue Whinstone (very hard)	1185	2·71	169½	0·33	nil	1·10	
Dec. 9, 1912	5	Sandstone Grit (hard)	2020	2·50	156	1·04	1·04	nil	
Dec. 9, 1912	6	Sandstone Grit (fine grained)	1512	2·55	159	0·99	0·72	0·13	
Dec. 9, 1912	7	Red Sandstone Grit	878	2·38	148	1·93	2·17	nil	
Dec. 9, 1912	8	Blue Whinstone	1140	2·59	162	1·05	0·96	nil	
Dec. 9, 1912	9	Norwegian Granite	552	2·64	165	0·72	0·18	0·18	
Dec. 9, 1912	10	Sandstone Grit (very coarse)	549	2·35	147	2·73	2·55	nil	

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TABLE II.—TESTS FOR ULTIMATE STRENGTH OF CEMENT MORTAR UNDER TENSION.

Date of making briquette.	Number of test.	Class of sand.	Proportions.		Exposure to		Fineness of sand.	Tensile strength. At breakage in lbs. per sq. in. (average).			Remarks. (Tests made on briquettes of 1 sq. in. sectional area.)
			Sand.	Cement.	Air (hours).	Water (days).	Size of mesh.	7 days.	28 days.	3 months.	
Dec. 13, 1912	1	Newburn (river)	1	1	24	6	400	361	557	477	NOTE.—Each test is the average of 6 briquettes.
Dec. 13, 1912	2	Newburn (river)	2	1	24	6	400	233	371	388	
Dec. 13, 1912	3	Newburn (river)	3	1	24	6	400	172	307	335	
Dec. 13, 1912	4	Newburn (river)	4	1	24	6	400	128	210	212	
Dec. 13, 1912	5	Newburn (river)	5	1	24	6	400	103	151	187	

TABLE III.—TESTS FOR ULTIMATE STRENGTH OF CEMENT CONCRETE UNDER TENSION. (CONTRACT PROPORTIONS.)

Date of test.	Number of test.	Class of aggregate.	Proportions.			Method of mixing.	Exposure to		Tensile strength. At breakage in lbs. per sq. in. (average).		Remarks. (Tests made on briquettes of 1 sq. in. sectional area.)
			Gravel.	Sand.	Cement.		Air (hours).	Water (days).	months.	breaking strain.	
Nov. 11, 1912	1	Newburn (river)	4·50	2·25	1·50	Machine	24	27	1	344	NOTE.—Each test is the average of 4 briquettes.
Nov. 11, 1912	2	Newburn (river)	4·50	2·25	1·50	Machine	24	54	2	415	
Nov. 11, 1912	3	Newburn (river)	4·50	2·25	1·50	Machine	24	81	3	411	

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CASTLE on TYNE CORPORATION

OUSEBURN VALLEY WORKS.

WORKS Nos. 1, 2, 3 & 4.

PLATE No. I.

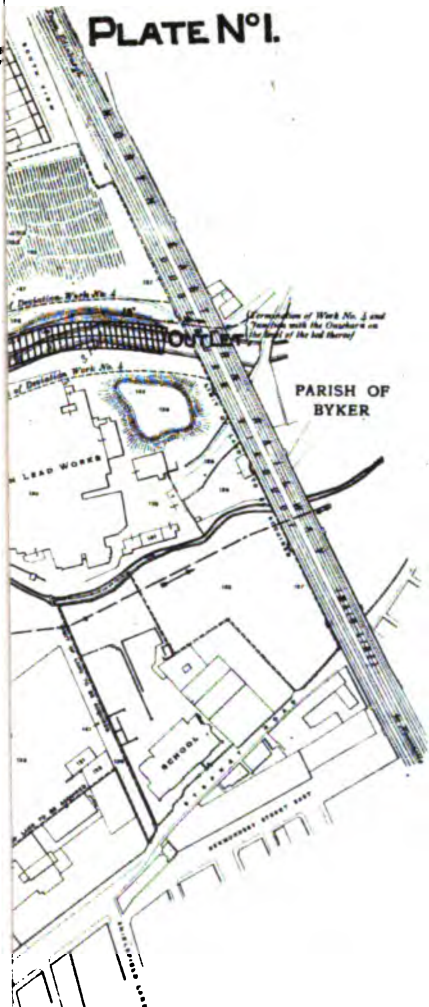

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TABLE IV.—TESTS FOR STRENGTH OF 4-INCH CONCRETE CUBES IN COMPRESSION. ALL CUBES SET IN WATER UNLESS OTHERWISE STATED.

Number of test.	Age of specimen.	Area (sq. ins.).	Proportions. Gravel.	Proportions. Sand.	Proportions. Cement.	Crushing strength in tons.	Crushing strength in lbs. per sq. in.
1	1 month	16	4·5	2·25	1·5	12·05	1687
2	1 month	16	4·5	2·25	1·5	11·13	1558
3	1 month	16	4·5	2·25	1·5	11·27	1578
4	1 month	16	4·5	2·25	1·5	10·22	1431
5	1 month	16	4·5	2·25	1·5	11·60	1624
6	1 month	16	4·5	2·25	1·5	11·01	1541
Average crushing strength						11·21	1570
7 (Set in air.)	3 months	16	4·5	2·25	1·5	17·81	2493
8 (Set in air.)	3 months	16	4·5	2·25	1·5	17·41	2437
9 (Set in air.)	3 months	16	4·5	2·25	1·5	15·90	2226
10 (Set in air.)	3 months	16	4·5	2·25	1·5	17·50	2450
11 (Set in air.)	3 months	16	4·5	2·25	1·5	18·25	2555
12 (Set in air.)	3 months	16	4·5	2·25	1·5	(not tested)	
Average crushing strength						17·37	2432
51	1 month	16	2·67	1·33	1	11·51	1611
52	1 month	16	2·67	1·33	1	16·05	2247
53	1 month	16	2·67	1·33	1	16·85	2359
54	1 month	16	2·67	1·33	1	15·01	2101
55	1 month	16	2·67	1·33	1	15·80	2212
56	1 month	16	2·67	1·33	1	11·48	1607
Average crushing strength						14·45	2023
103	1 month	16	3·34	1·66	1	12·22	1711
104	1 month	16	3·34	1·66	1	12·22	1711
105	1 month	16	3·34	1·66	1	11·78	1649
106	1 month	16	3·34	1·66	1	11·89	1665
107	1 month	16	3·34	1·66	1	12·60	1764
108	1 month	16	3·34	1·66	1	12·11	1695
Average crushing strength						12·14	1699

			Proportions. Gravel.	Proportions. Cement.		
25	5 weeks	16	4·5	3·75	19·28	2699
26	5 weeks	16	4·5	3·75	18·09	2533
27	5 weeks	16	4·5	3·75	19·17	2684
28	5 weeks	16	4·5	3·75	17·30	2422
29	5 weeks	16	4·5	3·75	16·00	2240
30	5 weeks	16	4·5	3·75	15·90	2226
Average crushing strength					17·62	2467

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TABLE V.—TESTS FOR STRENGTH OF 1-INCH (SECTIONAL AREA) CEMENT CONCRETE BRIQUETTES IN TENSION (SET IN WATER).

Number of test.	Age of specimen.	Proportions. Gravel.	Sand.	Cement.	Breaking strength per sq. in.
1	1 month	4·5	2·25	1·5	240
2	1 month	4·5	2·25	1·5	270
3	1 month	4·5	2·25	1·5	255
4	1 month	4·5	2·25	1·5	250
5	1 month	4·5	2·25	1·5	not tested
6	1 month	4·5	2·25	1·5	not tested
		Average breaking strength*			254
51	1 month	2·67	1·33	1	320
52	1 month	2·67	1·33	1	240
53	1 month	2·67	1·33	1	340
54	1 month	2·67	1·33	1	280
55	1 month	2·67	1·33	1	400
56	1 modth	2·67	1·33	1	330
		Average breaking strength			318
103	1 month	3·34	1·66	1	230
104	1 month	3·34	1·66	1	265
105	1 month	3·34	1·66	1	210
106	1 month	3·34	1·66	1	240
107	1 month	3·34	1·66	1	260
108	1 month	3·34	1·66	1	210
		Average breaking strength			236
25	1 month	4·5	nil	3·75	270
26	1 month	4·5	nil	3·75	330
27	1 month	4·5	nil	3·75	370
28	1 month	4·5	nil	3·75	340
29	1 month	4·5	nil	3·75	360
30	1 month	4·5	nil	3·75	370
		Average breaking strength			340

* For average breaking strength at 3 months (above proportions) see Table III.

TABLE VI.—TESTS FOR ABSORPTION AND SPECIFIC GRAVITY OF 4-INCH CUBES OF CEMENT CONCRETE. (CONTRACT PROPORTIONS.)

Date of test.	Age of specimen.	Class of aggregate.	Proportions.			Weight of specimen.	Specific gravity.	Calculated weight per cubic foot.	Absorption test at 24 hours.	Hydrochloric acid test at 7 days.	Remarks.
			Gravel.	Sand.	Cement.	(grammes)		(lbs.)	Percentage of absorption.	Percentage loss of weight.	
Dec. 9, 1912	14 days	Newburn (river)	4·5	2·25	1·5	2076	2·27	142	4·91	18·54	New culvert.
Jan. 18, 1913	2 months	Newburn (river)	4·5	2·25	1·5	2180	2·26	141	4·36	20·32	New culvert.

TABLE VII.—TESTS FOR ABSORPTION AND SPECIFIC GRAVITY UPON PIECES OF CEMENT CONCRETE CUT OUT OF THE FINISHED STRUCTURE

Date of test.	Number of test.	Age of specimen.	Class of aggregate.	Proportions.			Weight of specimen.	Specific gravity.	Calculated weight per cubic foot.	Absorption test at 24 hours.	Hydrochloric acid test at 7 days.	Remarks.
				Gravel.	Sand.	Cement.	(grammes)		(lbs.)	Percentage of absorption.	Percentage loss of weight.	
Dec. 9, 1912	1	6½ years	Newburn (river)	27	13·5	7·72	2312	2·33	146	4·20	15·04	Old culvert. Hearting of arch. Section 7.
Dec. 9, 1912	2	6½ years	Newburn (river)	27	13·5	7·72	221	2·27	142	4·07	46·51	Old culvert. Concrete from face of bars. Section 7.
Dec. 9, 1912	5	5½ years	Newburn (river)	27	13·5	4·84	1850	2·35	147	2·48	17·02	Old culvert. Thick piece from bench. Section 18.
Dec. 9, 1912	6	2 months	Newburn (river)	4·5	2·25	1·50	1079	2·33	146	2·59	21·04	New culvert. Internal face of arch. Section 1.
April 3, 1913	7	6 months	Newburn (river)	4·5	2·25	1·50	1003	2·25	141	3·99	24·00	New culvert. Internal face of arch. Section 1.
April 3, 1913	8	6 months	Newburn (river)	4·5	2·25	1·50	1791	2·29	143	4·02	10·27	New culvert. Internal face of arch. Section 2.

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DISCUSSION.

Mr. E. J. Silcock: I have much pleasure in proposing a vote of thanks to the Author of this paper for his description of what is an exceedingly interesting and important work for the City of Newcastle. This Ouseburn scheme is one of the public works which has been so much discussed locally that even people at a distance have heard the echoes of that discussion. We know there has been a great deal of controversy as to what was the best line to be adopted for dealing with this formidable barrier across the traffic of Newcastle. The basis on which the size of the culvert has been designed is a matter of great interest. I see that the original design was based upon a rainfall of 1 inch per hour for the whole drainage area of the stream down to the point where the culvert commences, and that 1 inch of rain per hour was estimated to all run off the drainage area as fast as it fell. One inch of rain per hour for anything like 25 square miles of area is a very exceptional fall. I was down in the neighbourhood of Norwich last August when that very celebrated heavy fall of rain took place, which amounted to 7 inches of rain in twenty-four hours. That was absolutely unprecedented in that district. The 7 inches fell during twelve hours, and during the maximum period of fall over 3 inches of rain fell in three hours. That is, the rate of fall was slightly over 1 inch per hour for three hours, and that, as I say, is almost unprecedented in this country, certainly in the Eastern Counties. And I take it, although we are much further north here, and the ground considerably higher, we are not, in Newcastle, in what would be described as a region of very heavy rainfall. The rainfall is nothing like that in the hill country in Cumberland. Therefore, the 1 inch per hour may be taken as being the absolute limit of what is likely to occur, if one considers the area of 25 square miles, and take the period of an hour. But the fall of rain and the rate at which it runs off the catch-ground are two entirely different things, and it depends upon the nature of the catch-ground, its perviousness, and its gradient as to how fast that water will run off. I must say, from the information which I have been able to obtain, that in my view Mr. Steele was fully justified in reconsidering the sectional area of this culvert before proceeding with the works when they came under his charge.

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Apparently he was able to obtain the gauging of an exceptionally heavy flood in 1900, which gave a yield from this valley of something like $\frac{1}{8}$ of an inch per hour from the catch-ground. That, no doubt, although a very heavy flood, would not be taken as being the absolute limit, and Mr. Steele provided in his design for a culvert which would take $\frac{3}{10}$ of an inch per hour. For some reason he seems to have increased that, and so he has got a provision of $\frac{4}{10}$ of an inch per hour. That in face of the gauge of $\frac{1}{8}$ of an inch per hour seems to be a very ample provision, and shows the original design of 1 inch per hour was certainly working on a very safe limit. The point which one naturally looks at after all is what difference in cost was made by this alteration in the cross section of the culvert. Obviously it must have been something important, and it would be interesting to know what the saving to the Corporation was to make this alteration in design. I know the question is complicated by this: that the original construction of the larger sectional area seems to have been undertaken when the Corporation had borrowing powers under an Act of Parliament, and when they would not have to submit their plans of construction to any criticising engineer. Subsequently, when the culvert was extended, we are told that the Local Government Board sanctioned the loan, and the details of construction had to be submitted to an engineering inspector, and as a result of that process the strength of the culvert was largely increased, so the cost of construction, as carried out, is not strictly comparable with the original design, but perhaps the Author will tell us what the saving would have been if constructed with the same margin of strength. The question which I have just referred to, that of strength, seems to have been dealt with by the model explained to us, and is a method of testing which rather appeals to one in the first instance as being a practical test, but one always has to bear in mind that, with a heavy bank like this tipped up with all sorts of materials, at various angles, and at different times, a heavy rainfall may alter the condition of the filling materials, and the load brought upon the culvert below is not truly represented by the conditions existing in a model, where the filling material was dry, and where there were not the alterations of the conditions taking place in the slopes. Obviously the whole of the superincumbent materials would not have to be carried by the culvert, and, having regard

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to the tests, the Local Government Board were severe in requiring the culvert to carry the whole load of the bank. I notice the levels at which this culvert is built, the invert level at the outlet end was fixed above the level of high water spring tides. Unfortunately I have not been able to see the longitudinal section of the valley, and the rise and fall of the tide. One would think it would be better to keep the culvert down at the outlet end, and so get a larger dis- charging capacity if the tide was down. Unfortunately floods do not always occur at low water. Indeed, there is some justification for the belief that heavy thunderstorms take place at high water. But the water does not reach the river the moment it falls, and even if it falls at high water it does not follow that the maximum discharge from the culvert would occur at the exact moment of high water. With a culvert of this size, if the invert had been kept down, say, 10 feet it would have improved the gradient, and instead of 1 in 140 it would have been 1 in 80, which would have given three times the discharging capacity when the tide was down, and the discharging capacity at high water would have been equal to the culvert as designed when it is running clear. This is assuming that the height of the tide will never be such as to absolutely submerge the end of the culvert. That is a criticism which one offers without a full knowledge of the facts, but still it is a point which one would like to have discussed. With regard to the rate at which this valley is going to be filled up, it seems to be work of very great magnitude from that point of view, and the Corporation will have to look forward to years and years of tipping to get the valley filled up, and the value of the work brought into full operation. I suppose there is no method of obviating that without going to a bigger expense than the Corporation are prepared to face. In this respect the diagram on the wall which deals with the number of houses built during the last twenty or thirty years is rather instructive, as one notices there has been a very material falling off since 1907. Soon after the extension of the city, the number of houses built was between 600 and 700 annually, it has fallen off to about 100 per annum. For a city of this importance to have only 100 or 200 houses built per annum shows there has been a terrible slump in the building trade. Perhaps we cannot discuss all the causes of it, but Mr. Steele

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may give us some information on that subject. I presume the falling off is only temporary, there probably was some over-building in the past, but that must be overtaken in a progressive city, and one may expect that a larger number of houses will be built producing surplus earth by which the valley will get filled up at a much quicker rate.

MR. C. E. RIVERS: I have much pleasure in seconding the vote of thanks to the Author of the paper. One point which has occurred to me is this—having regard to the enormous discharge and velocity of the flow when the culvert is running full, to the tortuous line of the same and to the fact that it will remain practically uncovered for some considerable time, could the Author inform us whether in designing the reinforcement any calculations were made of the tendency of the culvert to straighten itself longitudinally? We all know what happens to a tortuous line of fire hose when water is passing through it under pressure, and I am thinking that some such stress might be set up in the culvert when it is running full at such a high velocity. Mr. Silcock has touched upon the question of rainfall, and his remarks are practically identical with my views on the matter. It seems that an enormous amount of material will eventually be required for filling the valley, and although the rate of building has decreased to such a low limit during the last year or two, when building does increase it will take place on the outskirts of the city, and the cost of conveying the material to this valley will be very great. Will the Author inform us what provision has been made for the access to and ventilation of the sewer to be laid in the culvert? Apparently the only access will be at the two ends of the culvert.

MR. LESLIE ROSEVEARE: What struck me in reading this paper was the fact that Newcastle seems to have been fortunate from the very commencement with engineers who have the courage of their convictions. To start with, in 1894, when British engineers had a very prejudiced view of reinforced concrete, to put in a culvert 100 feet below ground showed the engineer had the courage of his conviction, and perhaps the suggestion of Mr. Steele to make the culvert of a smaller section showed more pluck than ever. The line of least resistance would be, provided the culvert in the opinion of the one responsible is large enough, to continue the work as before. It is not always a paying thing

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to do to cut down a section, but to do so shows a greater appreciation of the likely discharge from watersheds. It seems to be a subject in which, until recently, and often at present, engineers follow a rule-of-thumb method. Too often a fixed rainfall is assumed over the whole area without any data as to gradients or calculation as to its impermeability, and some of the junior engineers have been following the lead of their seniors by assuming the fall of an area to be similar to some other area elsewhere, where the engineer may have estimated ¾ inch, or ½ inch, or ¼ inch, or whatever it might be. After the paper of Mr. Lloyd Davies at the Institution of Civil Engineers there is no excuse for so doing. I notice that the intensity of rainfall at the greatest flood on this area is not obtainable; but although it is only an approximation—calculating on the average flow of the day at the lowest and highest records of the three rain gauges—it gives a return of 0·135 and 0·153 of an inch per hour, and the maximum flow-off, it is interesting to note, on this area of 16,295 acres, with a slope of about twenty-five feet to the mile, equal to a rainfall of 0·13 of an inch per hour, calculated as an impervious area. I notice the discharging capacity of Mr. Steele's completed culvert, with a time of concentration of 2½ hours, allows on an impervious area a rainfall of practically 0·42 of an inch per hour (incidentally less than one-half of the capacity of the original culvert). It may prove interesting to him to know that I have taken careful intensity rainfall readings over the last three years, and find that in only one storm during that three years did 0·42 inch of rain last for 35 minutes, and that the number of storms per year of this intensity, and their duration were—one for 23 minutes, two for 15 minutes, and five for 12 minutes. This suggests, as being taken in the same locality, that Mr. Steele has done the correct thing in reducing the size of his culvert, and is still on the safe side from the point of view of probable discharge, for even if this area is developed in its higher reaches, the extra flow which will come into the sewer will only be that due to the shortened time of concentration, caused by the fact that the water will flow down sewers rather than over the land. I do not agree with the Author that there is any difference in principle as between the calculations for this culvert and an ordinary system of sewers—it is only a question of degree. Taking the design of a culvert of this description, it is quite feasible that the size of the culvert might depend

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entirely upon the flow-off from an urban district forming part of the watershed, with a very quick fall and a resultant short time of concentration and resultant calculated high rainfall. It is quite possible that the culvert would have to be designed for an area similar to that suggested, rather than the whole of the watershed. The time of concentration for the latter would be lower, and the calculated rainfall would be correspondingly lower. I notice the Author suggests that the borings he took were absolutely wrong, or, rather, did not prove what they were going to experience. I have often thought it would be well to get a factor of safety as to the reliability of borings! I will give one example. In boring for a reservoir dam I was engaged upon, we came to rock in each case, about seventeen feet deep. When the ground was opened out, practically the only places where there was rock were the places where the borings had been put down, and we had at one point to go down 104 feet to find it. The experiments on arching were most interesting, and it is well that the engineers in large boroughs are in a position to carry out and give the results of experiments in the way they do, for the benefit of those whose funds do not allow it. I agree with Mr. Silcock that it was a pity the Local Government Board did not see their way to allow a little relaxation of their requirements as compensation for the trouble taken with and the results of the test experiments. But it should be noticed that the security of the arching depends upon the springing being immovable, and, having regard to the Author's statement on the uncertainty of the ground in the neighbourhood, this, apparently, could not be guaranteed. As to the lowering of the outlet, as suggested by Mr. Silcock, the strength of a chain is only its weakest link, and for these calculations it was desirable to calculate for the highest rate of flow at the high-water level.

Mr. George Nelson: When I first saw the completed section of this Ouseburn culvert at its mouth, two points struck me. One was that it was too large for its purpose, and the other was that the crown was constructed on almost precariously fine lines. Mr. Morgan says in his paper that it was originally designed to allow for 1 inch of rainfall over the whole watershed area, and the question resolves itself into whether he calculates that that amount of water is going to reach the culvert at one time or will be distributed over a period of time. It is usual in designing a sewer to provide for 1 inch of rainfall, but

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for only a quarter of that to be dealt with at one time. In the present case, this 1 inch, as it is agricultural land, seems to be a very large computation. I have observed, in times of comparatively heavy rainfall, and when the flow has had time to reach the outlet, there is a depth of only about eighteen inches of water in the culvert, or, in other words, the invert is scarcely covered, and that, as I say, in times of heavy storm. I see Mr. Steele has reduced the size of his section, and has also increased the thickness of the crown, which seems to bear out the impressions I got.

Mr. W. J. Steele: I do not want to encroach upon Mr. Morgan's province, but perhaps I may just deal with one or two of the leading points in reply to things which have been said. The provision to be made for carrying off the largest rainfall likely to occur, has raised an interesting discussion, and perhaps I need scarcely say that it gave Mr. Morgan and myself considerable anxiety. Rainfall charts were investigated over a great many years, and, what is of equal importance, the oldest men we could find, who lived on the banks of the stream, were interviewed. We were fortunate in finding an intelligent gardener who had known the stream for fifty years. He gave us various flood marks, which he had made out of curiosity, and this information was of great assistance in analysing the rainfall charts. A chart from an automatic recording rain gauge is submitted, showing the rainfall in one day in June, 1911. During fourteen hours of continuous rain there was a fall of 2·40 inches; but twice during that fourteen hours $\frac{1}{4}$ of an inch fell in an hour. We have had, of course, falls of much greater intensity, in some cases at a rate exceeding 1 inch per hour; but these only lasted a few minutes. The point was raised by Mr. Roseveare that the culvert is the same as a sewer, being only a question of degree. This is true; but the "time of concentration" was taken at $2\frac{1}{2}$ hours, which is very much greater than usually occurs in a sewer. Mr. Silcock asked the reason for keeping the outlet of the culvert above high-water mark. To begin with, I think one would only have the outfall of a culvert blocked by a tide, if such a condition was unavoidable. Here, a few feet did not matter, and it was possible to get a free outlet. But, there is another point, which is very much more important. Mr. Silcock said if we had dropped the mouth of the culvert we would have got a gradient of 1 in 80. A gradient of 1 in 80

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would have given such a high velocity, when the culvert was running only half full, as to be dangerous to the structure. We came to the conclusion that if we increased the velocity the culvert would not stand it; the friction would be so great that the lining of concrete might be torn from the reinforcement. There is another point raised as to the tipping into the valley, and the time it will take to fill up. When the new naval shipyard at Walker, of Messrs. Armstrong, Whitworth, and Company, was about to be constructed, and some 4,000,000 tons of material were to be taken to sea, we endeavoured to come to an arrangement with Messrs. Armstrong's contractor for a portion of that material to be conveyed to the Ouseburn valley, but the cost was prohibitive. It is true that only a small quantity of material is being tipped into the valley at the present time, but we hope to get a larger quantity when there is a revival in the building trade. To fill in the whole valley is a matter of a great number of years. Mr. Nelson mentioned the reinforced concrete construction. Several forms of construction were considered, including brickwork and a tube in cast-iron segments, but the cost of these was so comparatively great that reinforced concrete was adopted.

The President: I should like to repeat how very advantageous it is to our Institution to have such explanatory papers submitted to us. It is a pleasure to read a paper such as this from one of Mr. Steele's staff. It shows very keen investigation into the strength of materials before user, and it appealed to me very much in that every possible care had been taken to test everything before using, and it is an example to us to do likewise. I was interested yesterday in going down the river, and it did strike me that those four million tons of good English earth, which were sent out to sea, might have been used for filling this Ouseburn valley. Mr. Steele has explained why this was impossible, and no doubt the explanation is ample. Another question is as to the connections to the sewer inside the length of culvert. How will those connections be made or will any be made at all? Mr. Steele's reply with reference to the additional concrete is very much to the point. The reinforcement should do its work, and if it does not then it is not worth putting in. It is very useful to obtain the sections of the effect upon the model. We know what the Local Government Board is, and if they err at all—and they are mortal—

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it is on the side of increased safety, and the point which would appeal to them is the question of frictional resistance.

Mr. Morgan, in reply, said: I should like to thank you for the way in which you have received my paper. I think some of the criticisms which have been passed have been answered by Mr. Steele. There are, however, a few points that have been raised that I might reply to: Mr. Silcock asked what the extra cost of the culvert extension would have been, if it had been carried out on the same lines as the original section. It would have made a difference of more than 4000*l.* It is hoped that an improvement in the supply of filling to the valley will take place, and that we shall shortly be able to obtain it at a much faster rate. Mr. Rivers asked if we had provided any manholes on the proposed sewer through the culvert. We shall provide the necessary manholes, and access to the sewer will be obtained from the interior of the new culvert at intervals throughout its length. Mr. Roseveare raised a point as to borings. These are as a rule unsatisfactory. The borings were taken very carefully at intervals of about 50 feet, but, as is very often the case, we did not discover all we wanted to know! The borings were taken to a depth of from ten to twenty feet below the foundation; these consisted chiefly of shale, seggar clay, coal mixtures, sand, and soft gravel. In every case the unstable material was taken out, and the foundation carried down to the firm shale bed. In dealing with the rainfall, and estimating the discharge from the drainage area, we could not afford to take any risks of under estimation. We were faced with the fact that when the valley is filled in, the culvert will be the only means of outlet for the stream, and if an abnormal flood should occur at any time and the culvert prove inadequate to take the volume coming down through blockage, or other causes, the whole volume would be impounded by the filling acting as a huge dam, which would back up the water for a considerable distance with disastrous results to lands and properties in the higher reaches of the stream. Bearing this in mind, we decided to treat the whole of the catchment area as impermeable, and arranged to take the whole of the rain falling on the area direct into the culvert, allowance only being made for the time of run-off. The estimated time of concentration of 2½ hours for the rainfall to reach the culvert is also kept small, as in reality we know from frequent observations that the actual

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time is much longer. With regard to the calculations for the culvert. The structure is calculated as an arch fixed at the ends and continuous at the crown. The resultant load from 80 feet of filling above the crown of the arch was taken for the calculation of the bending moment. The various members of the reinforcement throughout the arch were calculated to resist this bending. The structure was also calculated to withstand a side loading; that is, assuming that the filling would be tipped from one side of the culvert only, and the reinforcements of the arch were made sufficient to resist these stresses. I might say a word as to the percentages of reinforcement. The ratio of the transverse reinforcement to the concrete is: In the original section, at the crown, 2·33 per cent., and at the centre of the invert 1·15 per cent. The new culvert is altogether stronger, the ratio of the reinforcement at the crown being 3·31 per cent., and at the centre of the invert 1·65 per cent. The dimensions of reinforcement are as follows: In the original section: inside main bars $\frac{15}{16}$-inch, and outside $\frac{15}{16}$-inch diameter placed at $6\frac{1}{2}$-inch centres, invert bars $\frac{15}{16}$-inch diameter placed at 10-inch centres, longitudinal bars $\frac{5}{16}$-inch diameter placed at 13-inch centres; stirrups $2\frac{1}{4}$ inches by 16 inches B.W.G. mainly. In the new culvert the inside and outside main bars are $1\frac{1}{8}$-inch diameter placed at 6-inch centres. The invert bars are $1\frac{1}{8}$-inch diameter placed at 10-inch centres. The longitudinal bars are $\frac{5}{16}$-inch diameter placed at 13-inch centres. The stirrups are $2\frac{1}{4}$ inches by 16 inches B.W.G. mainly. The load upon the foundations of the original section of the culvert is approximately 3·78 tons per square foot, and in the case of the culvert extension approximately 4 tons per square foot. With regard to the point raised as to the effect upon the culvert caused by the conditions of unequal loading, that would probably occur owing to the uncertain behaviour of the filling. We had to consider the question of the stability of the haunches of the arch due to an unequal settlement of the filling, and we endeavoured to find out by means of the model what the approximate measure of this would be. The model was made so that one side could be lowered to represent unequal settlement in the slopes of the valley during the process of filling in, the behaviour of the filling inside the model was carefully noted during the progress of the experiment, and the approximate resultant strain induced in the culvert by

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this case was taken into consideration in the calculations for the resistance to a side loading. We do not anticipate the foundations giving way because these have been so thoroughly put in and every provision made for contingencies. A few particulars as to the cost of the culvert may be useful to members. The cost of the first length of the culvert (original section) was 25,325*l.*, and the cost of the second length about 16,500*l.* The whole cost will be between 41,000*l.* and 42,000*l.* The cost per lineal foot for the original section works out at about 11*l.*, or about 1*s.* 6*d.* per cubic foot of reinforced concrete work. That was seven years ago when the cost of work was much less than it is now. When we came to carry out the culvert extension seven years afterwards the price of everything had gone up 50 per cent., and the tenders we received for the work were considerably higher in proportion than those for the original section. The cost works out at about 17*l.* 10*s.* per lineal foot, or about 3*s.* per cubic foot of reinforced concrete work. This is partly accounted for by the increased percentage of reinforcement in the culvert extension, and in a larger measure by the increase in the price of materials and labour all round. The above prices are for the reinforced concrete work only.

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NEWCASTLE-UPON-TYNE TRAMWAYS EXTENSIONS.

BY J. McKELLAR.

OF the 2600 miles of electrical tramways in the United Kingdom, representing a capital expenditure of 77 millions sterling, the City of Newcastle's contribution amounts to 60 miles and about $1\frac{1}{4}$ millions. Prior to 1899 the requirements of the citizens were served by a system of horse traction leased to a company. These lines were constructed of light rails about 65 lbs. per yard, laid on the Kincaid system paved with granite, principally of single track with passing places.

In that year the Corporation decided to take over the tramways by terminating the lease to the private company, and ultimately promoted a Bill in Parliament for power to reconstruct and extend the system. These powers being sanctioned, the actual work of reconstruction was begun early in April, 1900, and in December, 1901, the present electric trolley system of traction came into operation. At the opening of the service the mileage was just under 20 miles of double track; and this has been enlarged from time to time as required, the total number of miles at present amounting to over sixty, measured as single track. With the exception of the first 20 miles, which were constructed by contract, all the work has been carried out departmentally under the City Engineer, the gauge adopted being the standard one of 4 feet $8\frac{1}{2}$ inches, the centre way being 3 feet 6 inches for span pole construction and 5 feet 8 inches for centre-pole where the width of street permitted the larger space to be used.

The method of construction to-day varies but little from that as originally adopted by the then City Engineer, the late Mr. William George Laws, M.Inst.C.E., the few changes which have been made will be treated, subsequently, in this short description of the permanent way. Almost the whole of the original rails and other materials are still in use, which is sufficient evidence as to the quality of the work, notwithstanding the very normal costs

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incurred in maintenance. The only renewals carried out so far are about 500 yards each on two very steep gradients which had become worn out owing to the action of the magnetic brakes, and three of the original junctions. During the present year it is proposed to relay about two miles of route and seven junctions. The construction adopted follows the usual one of laying a concrete foundation 7 inches in thickness, the rails, after alignment, resting on a concrete packing, and paving the street surface with wood or granite. When wood paving has been laid, the concrete foundation is covered with fine concrete floating for a depth of 1½ inches. This floating is of equal parts of fine river ballast or crushed granite and cement. The type of rail adopted by Mr. Laws was of the grooved girder type, weighing 101 lbs. per yard, and very closely resembling the No. 4 section, which was standardised several years afterwards by the Engineering Standards Committee. The rails were principally of 45 feet lengths, and Table I. shows the chemical composition of that rail compared with those of more recent manufacture. The rails under review were made partly on the Open Hearth and partly on the Basic Bessemer process. The actual wearing of the rails left nothing to be desired, as may be gathered from a previous remark, as with the exception of two, or perhaps three, flakey rails, not a single fault or fracture has taken place which could be assigned to bad workmanship or material during that

TABLE I.

1899–1904. RAILS—ACID PROCESS.

	Per cent.
Carbon	0·50–0·55
Silicon, Phosphorus, Sulphur } not exceeding	0·06

1912. RAILS—LORAIN OPEN HEARTH PROCESS.

	Per cent.
Carbon	0·68 –0·69
Silicon	0·140–0·159
Manganese	0·74 –0·785
Sulphur	0·030–0·046

1913. RAILS—SANDBERG PROCESS.

	Per cent.
Carbon	0·43–0·53
Silicon	0·20–0·40
Manganese	0·90–1·40
Sulphur and phosphorus, not exceeding	0·08

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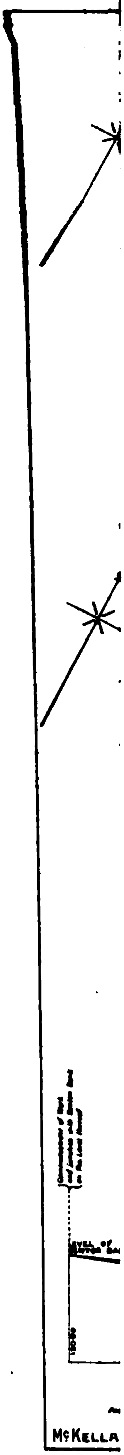
McKELLA

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interval. The original junctions and cross-overs were almost exclusively of American manufacture, with the standard points 12 feet long and 100 feet radius, and in the case of very flat intersections 14 feet points 200 feet radius were installed. They are of specially toughened cast steel with hardened centre. An iron-bound crossing with renewable centre pieces was fitted into all the turnouts. The leads attached to points and frogs were of ordinary rolled rail curved in workshops ready to be fitted into position. It is quite the general practice now to have the complete turnout made by the one steel works contractor, and although the Americans for a good many years had a monopoly of the contracts of this country, being the first to introduce the same, it is gratifying, from a national point of view, to know that the home producer is now fully alive as to his responsibilities and has since then had his share in this, no doubt, profitable industry.

The jointing of the rails, being the weakest part of the structure, has always been a concern to those responsible for the upkeep of a tramway system. Various kinds of joints have been tried to present a more or less rigid joint, in the endeavour to get rid of the knocking action which very soon appears, owing to the passage of the tramcars. In this city, following the standard practice then in vogue, plain fishplates were used (73 lbs. per pair). If the traffic is not too heavy, provided a good fit is obtained, it is doubtful if this can be improved on. One of the routes in Newcastle, about three miles long, with a five-minute service, is laid with this joint throughout, and even to-day the joints are all in very good condition, scarcely a single one having given out, although perhaps it should be mentioned that a large number of the cars used on this route are of bogie type. Another joint very much used in Newcastle is the continuous rail anchor joint, weighing 120 lbs. per pair, shown on Fig. 3. Many miles are laid with this joint, and, provided a good roll and fit is obtained, this joint is a most reliable one. Of the various kinds of welded joints that have appeared from time to time, during the last ten years, the Thermit welded joint has probably made the most headway. This joint has been adopted very largely by some corporations, notably Manchester and Leeds. Last year the company responsible for it were entrusted with over 800 joints on the eastern portion of our extensions, the work being executed by the Thermit Company themselves, and on its results will largely determine its

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future in this city. Unfortunately it requires some years to elapse before one can truly express an opinion.

Another weld of a different type, viz. the Tudor weld, has come before the public, of which favourable opinions have been expressed. This weld is somewhat more costly, but if found suitable and reliable, the extra capital sum required is of a secondary importance, as the maintenance on joints is a heavy one. The tie-bars were originally of wrought iron, but are now all of mild steel manufacture of 2-inch by $\frac{3}{8}$-inch section with 2–$\frac{7}{8}$-inch screwed ends, suitable nuts and washers to each, which were spaced originally at 12 feet centres, but are now reduced to 7 feet 6 inch centres, and weigh just over $16\frac{1}{2}$ lbs. each complete. The paving of tramway routes was confined to three different kinds, viz. wood blocks of Jarrah (Australian) wood, $4\frac{3}{8}$ inches in depth, granite cubes 4 inches by 4 inches by 4 inches, and granite setts 3 inches by 5 inches. The granite work of all paving in this town is almost exclusively from Aberdeen bedded on 1-inch sand grouted with whin chips and hot pitch. Drain rails are placed at convenient intervals.

The foregoing remarks may be taken as applying to construction in a general way, and consideration may now be given to the maintenance of the tramways based on that construction and the impressions to be learned from them in ordinary practice. The tramways had not been long in operation, and by the end of the first winter the weakness of the sand and cement packing made itself apparent, as this was washed out by water finding its way under the rail; consequently loose paving, especially wood, with "pumping" rails, soon made it clear that some other substance, if possible, would require to be used. Anchors were fitted in, in many instances indiscriminately, to be found more or less serviceable. When they can be put in at construction, they may be useful, but to attempt to fix anchors with the accompanying cutting and making good of concrete foundation and at the same time to maintain the tram service on busy thoroughfares, is almost impossible at other than about two, or at most, three months in the year, and that only if done during night time. The packing used in the attempt to meet the problem was nothing if not cosmopolitan. Trials were given to cement grout with several kinds of material as aggregate, and cement in similar materials dry or nearly so, as well as sal-ammoniac and pitch in many speciality forms. Some of them were more or

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less successful, depending on a number of conditions, but as climatic conditions play a not unimportant part in the North-east District, it was found that for the requirements of this city a mixture of equal parts of clean, sharp sand, whin chips, and cement just damped, could not be improved on, being convenient for nearly all weathers, and no special appliances required for fixing. The whole material being thoroughly rammed from both sides of rail—it is a waste of money to attempt this method from one side only—the top of concrete foundation is previously cleaned with hard wire brush and scrabbled, if necessary, to receive the new packing. Faulty packing may be responsible for all loose or low paving apart from the trouble of loose rails, and this one item represents the major portion of the maintenance costs, therefore every effort should be made to have a sound job made when the cost of the removal and replacement of the setts have to be considered. All trenches are closed every night. In two or three different points of the system wood sleeper construction has been carried out, both on the longitudinal and cross-sleeper fashion. Although it undoubtedly presents an easy-running road, it is costly to construct, and more so to maintain, as the wood sleepers (either method) become loose in time when there is much traffic, and as, from their shape and position, the water cannot readily be kept out owing to their greater depth in the ground, more excavation is necessary, which means, of course, an increase in cost over that of the ordinary concrete bed. In Table II. the cost per annum of the system per car mile, since its inception, are given.

TABLE II.

Year ended	Length in single track.			Combined cost of repair and renewals per car mile.
	M.	F.	Yds.	d.
March 31, 1902	18	2	135	0·01
" 1903	38	4	33	0·29
" 1904	44	7	134	0·66
" 1905	49	6	193	0·44
" 1906	52	4	0	0·31
" 1907	53	0	0	0·29
" 1908	54	1	0	0·34
" 1909	54	1	0	0·48
" 1910	54	1	0	0·36
" 1911	54	1	0	0·30

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The demand for improved travelling facilities between the city and the districts westward thereof, comprising Bell's Close, Lemington, Newburn, and Throckley, and also better connection between the central and eastern portion of the city, resulted in an Act being obtained in 1911, giving powers to further extend the system. These extensions are as follows:—

Tramway No. 1. This extension, which commences at the present terminus at Scotswood, 3¼ miles from the central station, extends to Throckley, a further distance of about four miles, and is constructed almost entirely within the Urban District of Newburn. The ancient highway that wanders through the villages of Bell's Close, Lemington, and Newburn is in many places so narrow that numerous street works had to be undertaken before any attempt could be made to lay even the single track upon which the Corporation had decided. The greater part of the cost of these works is to be borne by the Corporation, the Urban District Council contributing the fixed amount of 6300*l.* The track is a single one, with fifteen passing-places spaced about a quarter of a mile apart. The rails used are similar to those provided for the remainder of the extensions, that is, the Newcastle section of 101 lbs. per yard for the flatter portions of the route, the B.S.S. No. 5, 110 lbs. per yard, in Lorain steel, for any portions of the track steeper than 1 in 30, and the B.S.S. No. 5C, 116 lbs. per yard, for the inner rails of all curves quicker than 100 feet and for the curved rails of all the passing-places. With regard to the gradients, the steepest part of the track is 1 in 11 near to Lemington Station, but from Newburn village the line climbs from 20 to 255 O.D. The quickest curve is one of 47 feet centre radius at Lemington. Whenever practicable, the outer rails of the curves are super-elevated.

The design of the loops is shown on plan. The track is bonded at every joint with "Forest City" bonds with cross bonds every 40 yards apart. Respecting the bonding of points and crossings, wherever manganese steel is used, a special rail is embedded in the concrete, and bonds are taken from each end to the rails. It is worthy of note that manganese steel is replaced by cast steel for the special work in the passing-places and waggonways of any part of the track laid at a steeper gradient than 1 in 30, owing to the effect of the former on the electrical brakes of the cars. Regarding the street works for the number of which this route is somewhat remarkable, several

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points of engineering interest arise. In many cases, owing to a change in the level of the street, it has been necessary to lower the 30-inch mains of the Water Company which follow the track throughout, and this work has so far been carried out without breaking or emptying the mains. This was effected by opening out the whole length of the main to be lowered and slowly jacking the main to its new level and then recaulking the joints. Street Work No. 1, a section of which is shown, took three months to carry out. Street Work No. 10 involves an entirely new bridge to carry the branch of the North-Eastern Railway. By arrangement, this is to be carried out by the Railway Company at the cost of the Corporation and the District Council. In Street Work No. 11 the lowering of the road at this point involved the underpinning of the steel works of Messrs. Spencer & Sons for a distance of 800 feet. The walls of the works are in several places 4 feet thick and carry a very considerable load. This work has been successfully carried out by dealing with 3 feet only at a time and by leaving a distance of 9 feet between each opening; the part opened out was then carefully built in cement mortar and another 3 feet opened. Although the business of the steelworks was carried on continuously during the carrying out of the work, no movement of any kind has been observed.

Work No. 11*a* which involved the widening of the county bridge over the New Burn from 20 to 40 feet is now complete. The remainder of the Tramway works, although they involved the widening of the highway for a total distance of 2000 yards, nothing of very great engineering interest arose. The laying of the track and the carrying out of the street works (with the exception of Street Work No. 10) is being done by direct labour. In the supply of material, owing to the proximity of the railway and the river, it has been found to be difficult to decide rapidly from what district and by what method of transport it should be brought. Diagrams were prepared showing the price of every class of material at every point of the route, and from these it has been found possible to at once decide by what means material could be cheapest obtained on the work. Owing to the distance of some portions of the work from the city, the Corporation make an allowance of ¼*d.* per hour to every man working up to a point 2 miles from the city boundary, and ½*d.* per hour to every man working beyond that point. The construction of the track is on

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orthodox lines, as before described. The rails are all jointed with fishplates throughout of the continuous rail anchor type (see Fig. 3), which was decided on after mature consideration. At one time it was intended to use Thermit welds on the 101 lbs. rail, but owing to numerous colliery workings which exist in the district, it was deemed to be on safer lines if plated joints were used, so as to allow for any slight movement which might occur. The tramway is crossed by level crossings or colliery waggon-ways no less than eight times. These waggonways are, as a rule, crossing the tramway on a gradient, several with haulage ropes.

Tramways Nos. 2, 3, 4, and 5, which are double track throughout, present no unusual features, except perhaps that section in Benton Bank. Benton Bank is a road connecting the district of Jesmond with that of Heaton, immediately adjoining and parallel to the main road, and at a height of about fifty feet above its lowest level, is the Armstrong bridge. This bridge, which crosses the valley of the Ouse Burn at Jesmond Dene, carries vehicular traffic up to a load of six tons per vehicle, but is of too light a character to carry a tramway. The original gradient on the west side of Benton Bank was 1 in 9, and in order to obtain a gradient which would be less costly to work, the level of the road has been raised in the form of an embankment. Advantage has been taken of the opportunity to widen a portion of this road and also the masonry bridge over the Ouse Burn. This bridge has a span of 30 feet, is 23 feet in width between the parapets, and is being widened on each side so as to have a width of 50 feet. The west side of the bank will have a gradient of 1 in 12, and the east side 1 in 11. The maximum depth of filling is 12 feet, and as a consequence the existing water and gas mains, electrical cables, and underground telegraph wires have had to be replaced at a higher level for a length of about 280 yards. The total cost of the extensions, including street works and overhead equipment, is about 103,000*l.* The work is being carried out under the direction of the City Engineer, Mr. W. J. Steele, M.Inst.C E., and the Author is acting as Resident Engineer.

DISCUSSION.

Mr. H. W. Taylor: It gives me great pleasure to move a vote of thanks to Mr. McKellar for this admirable paper. The

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difficulties in dealing with such a road of extreme narrowness, with sharp bends and bridges to contend with, are very real. I think the way in which the Corporation of Newcastle has dealt with this road is admirable. Whether the Corporation of Newcastle has any ulterior motive in extending the tramlines westward, I do not know; but that this extension will be of benefit to the population of Newburn, Throckley, and Lemington I am certain, and I hope it will bring a financial return to the Corporation of Newcastle.

MR. GREGORY: I beg to second the vote of thanks. On some of the bridges the men could hardly put a spade down without coming into contact with gas or water mains, and it was most interesting to see the network of mains exposed.

MR. FOSTER: Mr. McKellar refers to the effect of heavy traffic upon rail joints. In my opinion heavy traffic is no more destructive to the joints than a lighter service of cars over a longer period. I have always found that high speeds are more destructive to both joints and rails than a heavy service of cars at low speeds. I have had some experience of continuous rail joints, and I agree with Mr. McKellar that they form an excellent joint if they are carefully fitted. In Leeds we have used the Thermit joint for eleven years, and it has been our standard joint for nine years. We had some trouble with breakages during the earlier stages, but it may interest the meeting to know that of the 7572 joints welded between the years 1908 and 1912 there have only been 37 breakages, or 0·4 per cent. With reference to the important item of rail packing, I may say that in Leeds we have had various methods. For some considerable time we used a system similar to that adopted in Newcastle at the present time by Mr. McKellar—broken steelworks slag being used in place of the whin chips. This was found to act very well, but some years ago we endeavoured to improve upon it, and at the present time we pack the rails with ¾-inch broken granite, and then run a mixture of hot creosote oil, and pitch to cover the rail flange, and we find that gives even better results. Care must be taken, however, that the mixture is uniform in composition, and at the right temperature. From Mr. McKellar's paper it appears that soft wood blocks have not been used on the Newcastle tramways. In Leeds we have tried both hard and soft wood (creosoted Archangel red deal) and we find the soft wood wears more evenly, and does not chamfer at the edges like

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the hard woods. I agree with Mr. McKellar as to the difficulty in fixing anchors after the track has been laid. Generally the application of anchors to loose or hogged-back rails has the effect of creating a number of short undulations where previously only one of easy camber existed.

MR. W. J. STEELE: I should like to pay a little acknowledgment not only to Mr. McKellar, but to Mr. Nash, who had charge of the difficult Newburn section. As Mr. Taylor pointed out, an unusual amount of subsidian work had to be carried out in laying this track. It involved the lowering of 30-inch water mains, and 24-inch gas mains, all within a very narrow road. You will get some notion of what it meant when I say that in a section of about 200 yards in length, the cost of lowering the mains was 800*l*. I am very glad to have the experience of Mr. Foster. He touched upon a point that I quite agree with, that next to joints, if not equally important, the packing under the rail is a vital matter in a tram track. I am glad to hear that our pitch packing has been a success at Leeds, I believe that to attempt too great rigidity in a tram track is a mistake. Another point mentioned was the reason for laying a tramway in Benton Bank instead of over Armstrong bridge. The whole question is one of cost. To have carried the tramway across Armstrong bridge would have involved the entire reconstruction of the bridge, because the present structure is not strong enough, and is too narrow. It is true that the gradient in Benton Bank is 1 in 12, but the reconstruction of Armstrong bridge would have cost ten or twelve times as much as the widening of Benton Bank. If we had laid the tramway at this great cost it would have made the route a very expensive one, and would never have paid for itself. In the mean time it is a way out of the difficulty of getting a connection between the two districts.

MR. TAYLOR: Mr. Steele has not answered my question about the probable returns on the Newburn tramway.

MR. STEELE: The only reason I have not answered that is that any figures given can only be an estimate.

MR. NELSON: We have in my district a tram track, belonging to another Corporation, with granite setts going through a macadam road. Would Mr. Steele tell us who he considers is responsible for the reinstatement of the macadam up against the setts. The practice is for the men, after repairing the setts, to simply brush in the loose metal alongside the latter, and this

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looks all right for about half an hour, but in time the traffic grinds out a dangerous groove against the setts.

Mr. Steele: I am an engineer—that is a legal question (laughter).

The President: A point which worries Municipal Engineers in the south of England is corrugation, and I should like to have heard more upon that subject. I have seen very little corrugation here, and congratulate the City Engineer and his assistants upon that. The question has been asked why the Corporation could not have temporised by using motor 'buses in carrying out this extension. I think Mr. Taylor would have found the condition of the road after a heavy service of motor 'buses would not be any improvement. Those of us who are cursed by motor 'bus services know the great injury they do to the ordinary macadam highway. I think the public will appreciate what the Corporation have done. And another point is the resilient packing of the tram rails. I am pleased to find that the Leeds experience agrees with that of engineers in the south of England. We had this question fully discussed at a recent meeting, and the opinion was that a resilient packing was more likely to give easy running than a rigid one. I did not gather whether you used it, Mr. Steele.

Mr. Steele: To a very small extent.

The vote of thanks was accorded unanimously.

Mr. McKellar: With regard to Mr. Foster's figures I am glad he has a high opinion of the continuous anchor joint, and he has a higher opinion of the Thermit welded joint. Without entering into any debatable matter I may say we have used tram Thermit since 1901, some have been a success, and others have not been. Last summer we used 800; we found the rails with the greatest number of fractures from Thermits where they are not holed, *i.e.* unpunched, at all. I do not think there is any chance of movement in these rails, and the fault I think must be ascribed to the Thermit joint. The Company has certainly a new method, and it has great possibilities; but we have had cars running over them for only a few months. Mr. Foster also mentioned anchors. A few years ago everybody put in anchors, four, five, and six feet apart. I am now following the lead of Manchester which never used anchors. Most engineers are now coming to the view that too much money has been spent on anchors. It is quite certain if anchors are not

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put in at the beginning, they are not worth putting in at all. I was doubtful about using these high-carbon rails for a time. The singular thing is that these high-carbon rails stood the tensile and other tests very well. The only doubtful one was the drop test. We wanted 15 feet; the most they would stand was 12 feet. With regard to this resilient packing, we have used packing of various kinds for a good number of years, but we found with the inclement weather, and especially such as last summer, it was difficult to get a decent job made of it. We had some arrangement made for pitch packing, but the season was against it. This year we intend to try pitch packing more generally. With regard to corrugation, for some reason or other in Newcastle we were late in getting corrugations. Until 1905, which was two or three years after other Corporation tramways, we did not get corrugations. We grind out the corrugations when they appear.

A vote of thanks was passed to the Lord Mayor and Corporation for the use of the Council Chamber for the meeting.

On Friday, the Lord Mayor kindly entertained the Members to luncheon in the Town Hall. In the afternoon they were the guests of the Tyne Commissioners, who placed the steamer "Sir W. A. Stephenson" at their service, for a cruise down the river Tyne. Tea was provided on board.

On Saturday, the Improvement Committee entertained the Members to luncheon at the Town Hall. In the afternoon visits of inspection were made to the Quayside, Ouseburn Valley Works, Benton Bank bridge, widening and tramway, and to Jesmond Dene, where afternoon tea was served in the banqueting hall.

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SCOTTISH DISTRICT. MEETING AT DUNDEE.

June 6 and 7, 1913.

Held in the Victoria Art Galleries, Dundee.

R. J. THOMAS, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Members were received by Lord Provost Urquhart, who offered them a most cordial welcome to Dundee.

The President thanked the Lord Provost for his kind reception and welcome.

The following papers were discussed.

RECONSTRUCTED DUNDEE.

BY A. H. MILLAR, LL.D., F.S.A.SCOT.,
CHIEF LIBRARIAN, DUNDEE.

THERE is nothing more certain than the uncertainty of all sublunary things. Change, decay, and renascence are visible throughout the wide field of Nature; and these are not less visible in the works of man. The old Greek philosopher lamented that one can never cross the same river twice, because its waters are constantly changing; and Shelley mourns thus over the empire of Change—

> "Man's yesterday may ne'er be like his morrow;
> Nought may endure but Mutability."

All history confirms that statement, and it is especially

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applicable to the work of human hands, to the towers and palaces erected in remote ages, as to the habitations that are decaying or rising anew upon the ruins of the past.

> "Beside the eternal Nile
>   The Pyramids have risen.
> Nile shall pursue his changeless way;
>   These Pyramids shall fall;
> Yea, not a stone shall stand to tell
>   The spot whereon they stood.
> Their very site shall be forgotten,
>   As is their builder's name!"

There is profound philosophy in the quaint remark of the French humorist who wrote thus: "Change sweepeth over all things earthly. And since Thebes is in ruins, Nineveh o'erthrown, and Rome but a saddening relic of former greatness, it is no wonder that *my old coat is out at the elbows.*" Much of the decay and evolution that are proceeding silently but inevitably around us is imperceptible; and this is especially true regarding the gradual destruction and re-erection of a great city. Day after day important changes are taking place in the form and fashion of its buildings; and these often pass unnoticed during the operation until the beholder suddenly opens his eyes to find that familiar landmarks have been removed, and places once well known are altered beyond recognition. The ever-flowing tide of time, the progress of humanity, the altered conditions of urban life, make it certain that such changes *must* take place by the inexorable law that governs all human affairs. This sounds like an obvious truism when stated thus baldly; and yet the idea of controlling these developments in city architecture is only now beginning to be realised. The forester knows that a tree will grow, by natural impulse, in a certain way, and he adopts measures to utilise this law of growth to suit his purposes. But until lately there was no intelligent attempt to regulate the development of a great city so that in the future it might be both beautiful and useful. The science of town-planning is yet in its infancy, though the need for it has been clamant for centuries. Old buildings have been removed and new structures erected in a haphazard fashion, and the result in most cities has been a mere collection of incongruous items, forming a heterogeneous mixture of different styles of architecture, each shouting loudly in derision of its neighbour. It was not so in ancient Rome. There the erection

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of new buildings was governed by the Senate through the Aedile and his officers, and the result was a harmonious city that is still impressive and glorious even in decay. Unless similar control is exercised in our modern cities by far-seeing designers and competent officials, we shall never make our cities ornate yet commodious, pleasant to the eye yet fitted for all the requirements of modern life. Fortunately this is now being largely adopted in most large cities, and Edinburgh, London, Glasgow, and Dundee have all experienced in some degree the beneficial effects of this method. It will be instructive to consider what has been done and is proposed for each of these cities.

Edinburgh was the first Scottish city to undertake reconstruction upon a large scale, and the movement was begun through the advocacy of three famous literary men, Sir Walter Scott, Francis Jeffrey, and Henry Cockburn. About the middle of the eighteenth century, a notable Lord Provost of Edinburgh —Sir George Drummond—had sketched an outline of urban improvements in the city; but funds were not available, and very little of Drummond's plan was carried out. With the dawn of the nineteenth century a new spirit was infused into city life by the earnest endeavours of Scott and his two friends; and as money was more plentiful and civic rulers less hidebound in their ideas, a great reform was initiated. Many of the obsolete and insanitary buildings in the centre of the city were demolished, and replaced by elegant modern structures; the New Town, including Princes Street—said to be the most picturesque street in Europe—was laid out and completed; and before Scott's death in 1832 he saw realised many of his dreams for the improvement of what he loved to call "mine own romantic town." Henry Cockburn was the most active of the three reformers, and his work has been recognised by naming Cockburn Street, which he designed, after him. Vast improvements have been effected up till the present time, and many other reforms are in contemplation.

The history of reconstructed London begins in 1666, the year of the Great Fire, when nearly the whole of what is now the centre of the city—St. Paul's Cathedral and the vicinity— was destroyed, and reconstruction became imperative. Here was an opportunity such as occurred but once in the history of the country. The time called loudly for the man, and he

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appeared in the person of Sir Christopher Wren. When that giant among architects was only thirty-four years of age he prepared a plan for the renovation of London, and he was at once appointed "surveyor-general and principal architect for rebuilding the whole city." This work he saw carried out, and during his long life—he was ninety-one when he died—he designed and erected over fifty churches, besides St. Paul's Cathedral, which is the admiration of the world. In the course of time, however, London fell back from the position it took in 1666, and urban reform ceased to be regarded as urgent. Not until after the Great Exhibition of 1851 were there any definite proposals for reform. In the early sixties the Thames Embankment was completed, being the first attempt to make the riverside attractive. The late Mr. Ayrton (died 1888), who was first Commissioner of Works, strongly advocated street reforms (such as the Holborn Viaduct and the widening of Fleet Street and the Strand, now in process of completion); but it was not until the London County Council came into existence that much progress was made in city improvement. Within the past twenty years some of the worst slums in the centre of London—the Drury Lane district and Soho to Bloomsbury—have been removed and replaced by splendid streets and avenues, such as Kingsway, Aldwych, Rosebery Avenue, and Salisbury Avenue. When the Metropolis has begun the work of serious reform, the cities in the provinces are certain to follow the example.

The history of the Improvement Trust in Glasgow is full of valuable information for Dundee, taken either as a warning or an example. As the Author happened to have a close connection with the work done in Glasgow during the currency of the Improvement Act—1866 till 1896—he can speak from first-hand knowledge regarding it. Indeed, two large illustrated volumes entitled, "Quaint Bits in Glasgow," and "Bygone Glasgow," were written by the Author, specially for the purpose of having pictorial records of the city of an earlier time. The original drawings for these volumes, made by David Small (now of Dundee), were purchased by the Corporation of Glasgow, and are now in Kelvingrove Art Galleries, and in the People's Palace, Glasgow Green. What the Author has now to say may be taken as authentic. The figures given herein have been compared with those officially published by Sir James Bell,

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Bart., who was Lord Provost of Glasgow from 1892 till 1896, and had the task of completing the work sanctioned by the Act of Parliament in 1866.

It may be well to inquire why there are "slums" at all in such cities as Edinburgh and Dundee. The reason is not obvious at first sight, but it may be easily explained. Edinburgh and Dundee were both walled burghs, with fortifications to prevent the invasion of an enemy; and, as the area was limited, the streets were narrow, and the tenements lofty. The necessity for such defensive works passed away in the course of time, but the buildings remained, for it is no slight task to reconstruct a city upon modern lines. The slums in Glasgow arose from quite another cause. That city was never enclosed by a wall. It was what is described in old Acts of Parliament as "a nakit town," undefended by walls or battlements. And yet sixty years ago there were slums in Glasgow worse than any either in Edinburgh or Dundee. In the City Improvement (Glasgow) Act of 1866, the preamble reads thus: "Various portions of the City of Glasgow are so built, and the buildings so densely inhabited, as to be highly injurious to the moral and physical welfare of the inhabitants." "When the vivid pictures of overcrowding in dirty, dark dens, drawn by impartial observers early in last century are realised; when we are told that the devastating plague of typhus was never absent, and that it frequently burst into epidemic eruptions of deadly violence; when we think of the dense accumulation of misery, vice, crime, and disease, of all that makes life repulsive and unbearable, we are ready to wonder that official persons spoke with complacency and satisfaction of the affairs of Glasgow, and that, for their own protection, the citizens did not insist on the application of curative measures to the terrible evils." Sir James Bell and Mr. James Paton, in their valuable book, "Glasgow, its Municipal Organisation and Administration," write thus: "The overcrowding which worked deadly havoc in Glasgow cannot be traced further back than the last quarter of the eighteenth century. It was when cotton-spinning on the factory system was introduced that the population began to increase with phenomenal rapidity. Large masses of people from rural villages crowded into the city, and within its narrow limits they had to find somewhere to lay their heads. The ancient lines of streets were closely built up, but behind the houses there were ample

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open gardens. These gardens were built over with tenements so closely packed together as to leave bare means of access to their doors and stairs; the front houses were deserted by their well-to-do occupiers, who withdrew to more open outskirts, and their dwellings were divided up into many separate houses of seldom more than one apartment. There was no power to stay this reckless and detrimental activity, and all the region on both sides of the High Street, from the College downwards, the Gallowgate, the Trongate, west to Stockwell Street, and thence to the river and the Saltmarket, were packed so closely that neighbours could shake hands (or rather fight) from their windows across the narrow space left between tenements. And this, be it remembered, was the state of things when the water supply was still obtained from public wells, when sewers were unknown, and drains had no existence, and when filth was private property, to be removed only when a price could be obtained for it."

The first move towards city improvement was made in 1860. Several philanthropic citizens, amongst them being Sir James Campbell of Stracathro, Lord Provost Blackie, and William Campbell of Tulliechewan, formed themselves into a private Improvement Trust, and established a fund for the purchase and removal of insanitary dwellings. At the same time the construction of the City Union Railway was in progress; and many of these tenements in the Saltmarket area were purchased and demolished to make way for the line. Plans were prepared for the reconstruction of the centre of the city on a gigantic scale; and it seemed possible that a new Glasgow would arise phœnix-like from the ruins of the old one. But it was soon found that the task was far too great to be accomplished by private enterprise. The money required was beyond the reach of even the wealthiest citizens, and the funds were soon exhausted, being invested in unproductive property. The want of compulsory powers of purchase rendered these philanthropic efforts futile. In 1865 Lord Provost Blackie, with full knowledge of the extent and difficulty of the undertaking, guided a committee of the Town Council in the preparation of an Improvement Bill, which passed through both Houses of Parliament without opposition, and received the Royal Assent in June, 1866. This Act constituted Improvement Trustees, and the original private committee handed over the property that had been acquired at cost price.

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The Author need not give a detailed history of the operations of the Improvement Trust during its existence of thirty years. Suffice it to say that between 1870 and 1877 the demolition of insanitary houses and the erection of healthy tenements proceeded apace. There was a perfect boom in the building trade. The two estates of Overnewton in the west and Oatlands in the south-west were purchased and laid out with streets and drainage, and these were speedily filled with better class houses.

We turn now to consider the history of Dundee; nothing that the Author says will be without secure foundation in ancient documents. The origin of Dundee will be found in a little fishing village at the Stannergate, which must have been founded long before the Romans invaded Britain in 55 B.C. The inhabitants evidently led what we now call the "simple life." They existed chiefly upon mussels and cockles and the harvest of the sea, and some of the shells of the shellfish they devoured are now in the museum. But then, as now, there were men who had a broad outlook, heroes who saw that Dundee might be developed upon extended lines; and some prehistoric city architect, in those remote times, foresaw that their trifling little village might develop into a great city, rivalling Rome itself. The Author would like to think that the only perfect skull of our remote Stannergate ancestors was that which contained the active brain that saw the necessity of moving westward. But this city architect, like later fellow-professionals, found that everybody did not agree with him when he proposed that the village should be removed to near St. Nicholas' Craig (now the site of the Tay Bridge Station). In those days, when a man did not agree with you, there was a simple method of getting rid of the obstruction The city architect of the period simply took out his stone hammer and cracked the skull of his opponent, to learn whether that opponent had any brains at all. And it may be that we have now in our Dundee Museum the split skulls of two of those objectors whom our primeval ancestor converted to his own views by this drastic method.

In any case, it is certain that the centre of our present Dundee was laid at Craig Pier; and from this primitive nucleus there has been evolved by a long process, our own beloved city. The Author will not relate in detail how the Castle of Dundee arose; how the Church of St. Mary was founded to eclipse the earlier Church of St. Clement, the patron of sailors. All he can

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do now is to say that for the first five centuries of the Christian era Dundee flourished exceedingly, that is, having regard to the slow progress of those leisurely days. No doubt there were slums even in that remote period; but every now and then our kindly enemies of England sailed up the Tay, and demolished with their cannons some of the worst of our Wynds and Closes. These English invaders—quite unintentionally—led our ancestors to see the horrors of over-crowding. They did not do so in a kindly spirit. Our splendid Tower of St. Mary—the Auld Steeple, as we affectionately call it—was not completed with the open Crown which the original architect had designed, though some of the stones prepared for this work were lying at the base of the Tower. But those ruthless invaders in 1558 not only took these finished stones, but tore up the tombstones of our ancestors, so that they might erect on the summit of our good unfinished Tower a Cape-house, from which—as one of their leaders says—they might "pott the inhabitants." The Author regrets to say that some of our modern civic reformers, unconscious that this abominable and disfiguring erection is a symbol of English tyranny and brutal domination, have resisted the idea of placing the Crown upon the steeple, which, delayed for five centuries, would show the independent patriotism of modern Dundee!

To come to solid facts as to the historic improvement of Dundee, the Author may startle some of you by saying that the first civic reformer of our burgh was the famous George Dempster of Dunnichen. The Author would like to tell you something about this great Scottish hero, but time forbids. Suffice it to say that George Dempster was born in Rankine's Court, off High Street, Dundee, in 1732; was an M.A. of St. Andrews University; and was M.P. for the St. Andrews Burghs (which then included Dundee) from 1761 till 1790. His character is sufficiently indicated in the pregnant line by which Robert Burns describes him:

"Dempster, a true blue Scot, I warrant."

With his political career we have not at present anything to do. That you will find detailed in the sketch of him which the Author wrote for the "Roll of Eminent Burgesses of Dundee," issued by the Town Council in 1887. What the Author has specially to say is this—that in recent times there was no

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contemporary to compare with Dempster in his broad outlook as to the possible development of Dundee. Think, for a moment, as to the limits of Dundee in his time—say, the latter quarter of the eighteenth century. Eastward, the burgh did not extend beyond St. Roque's Lane. Westward, its limits were Seres Wynd (now Long Wynd). On the north the boundary was the Bucklemaker Wynd (now Victoria Road), and this was the burgh which George Dempster sought to extend. How did he do it? In those days the main road to Perth was by the Hawkhill; but Dempster bought up the feus of Westfield and Springfield, and laid out—in 1788, mark you, 130 years ago—the lines of the present Perth road. The impetus thus given to expansion soon made itself felt. Provost Riddoch, who was practically Provost of Dundee from 1788 till 1818—thirty years—followed Dempster's example heartily. He planned and laid out Castle Street and South Tay Street; opened up Tally Street; extended the Perth Road to its junction with Hawkhill; devised and advocated the extension of the Harbour, ultimately known as Earl Grey Dock (though not completed till after Riddoch's death); and all these reforms were carried out by him in the midst of a storm of obstruction and personal abuse that would have discouraged a less equable Provost. But Provost Riddoch, absolutely certain about the value of the schemes he had proposed, carried through the work with undeviating unity. He was accused of making money out of his schemes, of plotting and planning to have his own projects carried out in defiance of objectors.

Using modern Parliamentary language, the Author may now take a "Kangaroo" leap over half a century. The removal of the Trades' House, which stood at the east end of the High Street, opened the eyes of our relatives of the "seventies" to the possibilities of street reform. To open up the east end of the High Street, and to leave its main access as a narrow, sixteenth-century lane, was obviously out of date. But there were then no powers in civic affairs to warrant any alteration. The Author's own opinion is that an Act of Parliament passed by James VI. in 1586 would have given an ample margin to our civic rulers of forty years ago to remove the objectionable Murraygait buildings compulsorily, and to have carried out the widening of the Murraygait at the expense of the landlords. But, very wisely no doubt, the Town Councillors of that time

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(say, 1868–78) were inclined to give what is known in law as "compensation for disturbance." Briefly, in 1870—to give a general idea of the time—the late Mr. Frank Henderson, who was Town Councillor in 1868, and M.P. for Dundee in 1880, took up the question of improvement of his native city, and brought out a scheme which transformed the centre of Dundee into a comparatively pleasant civic Paradise, and on the works fully half a million sterling was expended.

Leaving the work of the former Dundee improvement the Author may turn your attention to the scheme which has now been placed before the citizens of Dundee, and on which a further half million sterling is proposed to be expended. First of all, Mr. James Thomson, our present city engineer, has been concerned in various capacities, in all the schemes of our urban improvement that have been proposed and carried out during the past thirty years. He knows, therefore, what has been suggested, and he knows also—which is much more important—why and how certain proposals were rejected. Hence he occupies a quite unique position regarding the scheme at present before the public.

And having now reached the present day are the Community of Dundee to neglect the magnificent topographical opportunities which are presented, and to be content to jog along in the old-fashioned way, and let minor burghs displace us? They have the place—a magnificent location—they have the men, and they have the money too. It will be a lasting disgrace upon this generation of Dundonians if they do not rise to the occasion, and initiate a scheme of town reform and town planning which will receive the cordial applause of coming generations.

There comes next the question of expense. This is essentially a Scotch way of looking at things, but a very sensible method all the same. It is not necessary to go into the vast subject of the cost of Mr. Thomson's scheme; every business man knows that it is extremely difficult to estimate the cost of the work, and still more difficult to state the revenue of such a gigantic proposal, but reliance is placed by those in authority on Mr. Thomson's experience, and if it be possible to carry out the scheme for a loss, as he estimates, of 200,000*l.*, the Author should say that Dundonians of the present day, if they were to reject these proposals, would call down upon themselves the objurgations of their successors. The City

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Engineer records in his report upon the scheme, that while "the works taken as a whole form a scheme of some magnitude, it has been devised, as any such scheme should be, in a comprehensive manner, more than adequate for the requirements of the present day, and with due regard to the future of the city." And all will agree that had Dundee and other large towns had a well-considered and comprehensive town plan, millions would have been saved to the ratepayers of the country by forbidding work that should never have been done.

Dr. Millar, who supplemented his paper by a number of lantern slides of old and historic buildings in Dundee, of slums which are to be swept away, and of Mr. Thomson's plans for a reconstructed Dundee, with a new civic centre, said—those citizens who have seen the drawings have said it is all a dream. After what you have seen you will agree with me, if it is a dream, it is a glorious dream.

DISCUSSION.

The President: It has been to us really a very great pleasure to hear Dr. Millar's witty and pointed remarks with regard to this ancient city of Dundee. Those who have read the paper will appreciate his point of view, and his very kindly references to our friend Mr. Thomson. I do not know whether the members wish to, or really can, discuss this paper. It is a paper unique in itself, and entitles the Author to our very keenest thanks. I do formally, but with very great pleasure, propose that our sincere thanks be accorded to Dr. Millar for his excellent paper and the views with which he has illustrated it. I do not know whether any member will have any remarks to make on this very interesting paper, wherein Dr. Millar refers so kindly to Mr. Thomson, and although, as he says, Mr. Thomson's plans may appear to some to be glorious dreams, yet the results he has already accomplished will quite convince us that Mr. Thomson carries out his schemes in a practical way, and with admirable results, and we can hope that Dundee will ere long see their completion.

Mr. J. Walker Smith: With very great pleasure I second the vote of thanks which the President has proposed to Dr. Millar. I should be sorry if a paper of this kind were to pass entirely without discussion. I agree that the tone of the paper

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is pitched very high, and it is perhaps difficult for practical men like municipal engineers to rise quite to the high tone the Author has struck. Personally, I was immediately impressed by the subject, and delighted with the manner in which the subject was presented. I am sure you will agree with me it is presented in such a manner as does credit to the literary reputation of the Author. We have seen these beautiful plans of Mr. Thomson's in their original form and also as lantern slides. They are really more than plans, they are works of art, and an art gallery is quite the right place for an exhibition of such works. I can understand perfectly well that a man with the aims and ideals of the Author should find pleasure in advocating an early commencement of this beautiful and comprehensive scheme. It is an ambitious scheme, but it is no bigger, and no more ambitious, than the beautiful situation of Dundee deserves. One admires a beautiful city like Paris or Vienna—more beautiful in many respects than Dundee—but one cannot help thinking that Dundee presents natural advantages and attractions that are denied to those more beautiful cities. I have often thought that the situation of Dundee is unique. Gently sloping —with a southern aspect—down to the waters of that peerless river, I have often thought if one could start now and plan the whole city—when I say one, I mean one with the artistic and imaginative ability of the city engineer and architect—it could be planned out with beautiful terraces and open spaces, and with monumental buildings suitably located. The view would then become positively delightful, and comparable only with that which one gets when entering the bay of Naples. While one cannot start *de novo*, it is apparent that steps are being taken for beautifying the city, and I sincerely hope that something of the ornamental nature that is now proposed may be carried into effect. I have the greatest pleasure in seconding the vote of thanks.

The vote of thanks was passed unanimously.

DR. MILLAR, in acknowledgment: I thank you, Mr. President and gentlemen, for listening so patiently to my paper, because I know some English people have grave doubts as to where Dundee is. I hope I have shown you that there is such a place as Dundee, and that it is a city of no mean reputation.

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MAINTENANCE OF COUNTY ROADS IN DUNDEE DISTRICT.

By JAMES B. ROBERTON (*Member*),
County Road Surveyor, Dundee.

The following notes submitted at the invitation of the Hon. District Secretary are made through a desire to contribute to the general stock of reliable practical information which is so much required by road surveyors at the present moment, in their arduous task of facing the new conditions of road traffic which have arisen in recent years.

When considering the question of road maintenance, it is well to remember that it is much more difficult to deal with the repair and improvement of existing roads than it is with roads which have been originally well constructed. In other countries, such as France, for example, the roads were made primarily for military purposes, and were properly laid out and constructed from one centre to another regardless of cost, and it is well known the French roads, up to recent years, were the admiration of the world. In Scotland it is otherwise, as, with the exception of the old main turnpikes—General Wade's roads in the Highlands, and Telford's roads in the north—which were laid out with much engineering skill, it is well known that the public roads in Scotland have become what they are through the process of evolution—first as pack-horse roads, which later developed into roads suitable for wheel traffic. Taking a retrospect of the last forty years, it must be owned that much has been done to improve Scottish roads, and road authorities have not been slow in acquiring steam-rollers and other modern machinery to aid in this work. Many of the Scottish roads, however, have even yet but a skin of metal on the surface, and require strengthening to withstand the effects of the new conditions and kinds of traffic which have arisen. Suffering from the effects of traction-engine, motor-lorry, motor and general

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heavy traffic, there is a danger of being carried away by novelties in road maintenance which it may be prudent to avoid.

In this district, and under the conditions described above, the roads have been strengthened in some instances by increasing the thickness of the crust with 3-inch hand-broken metal, and in other cases where traction-engines and motor-lorries had to be taken into account the entire reconstruction of the road was taken in hand. This reconstruction consists in putting down a layer of 6 inches of bottoming with a top coating of 6 inches of 3-inch hand-broken metal, bound with whinstone chips from the breaking-machine. It is hoped that it will be possible to apply the most up-to-date surface preservative and binder in the market. In the writer's judgment this was the only possible way of meeting the difficulty in a satisfactory and lasting manner, and with some chance of keeping the road in fair condition at a moderate expense in the future. The Imperial Road Board, after a careful inspection, were satisfied that the right steps were being taken, and accordingly voted a grant of 3000*l.* towards a total expenditure of 7500*l.*, which was required for strengthening the Perth road, and for putting 5 miles of the Dundee-Coupar Angus road in a fit and proper state for carrying the mechanically propelled traffic to which it is subject at the worst period of the year, namely, the early spring months. The cost of this reconstruction of 5 miles of the Dundee-Coupar Angus Road works out at 2*s.* 2*d.* per superficial yard. A lighter form of reconstruction previously carried out on another portion of the same road was done at 1*s.* 10*d.* per superficial yard. The cost of strengthening the crust of the Dundee-Perth road with 6 inches of 3-inch hand-broken metal, with a finishing coat of 2½ inches machine-metal, cost 1*s.* 4½*d.* per superficial yard. In the writer's opinion the County Council are receiving good value for their money, as the material is in the road, and is a valuable asset.

With regard to the question of whether the foundation should consist of stones set on edge and wedged on top on Telford's principle, or by Macadam's method of roughly breaking the stones and spreading 6 inches thick with the metal applied on top in both cases, in the usual way, the writer found that, taking into consideration that the traffic must be kept going, the macadam principle was preferable, and the wearing results after three years were much the same, as was also the cost.

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The writer, however, is of opinion that for heavy traction-engine work stones set on edge, like the cope-stones of a dry-stone dyke in Scotland, are more fitted to withstand the pressure of the heavy loads.

Macadamised roads are often talked of as if the mere application of broken stones constituted such a road, but Macadam himself laid down as an indispensable rule that the foundation of the road should be thoroughly dry and above the level of the adjacent land. He pointed out that the stones should unite by virtue of their own angles and form a crust or roof over the foundation to keep it dry. The surface also was to be kept clean. Telford, again, stipulated for a rough stone causeway as a foundation with small metal on top. Whichever foundation be adopted, it must be kept dry by efficient drainage. Unless the foundation of a road be kept dry no bottoming will avail, and the crust must also suffer. Roads, like bridges or houses, must have a good foundation. In the writer's opinion, close attention to the elementary rules of road maintenance is being insisted on, and with the best results.

Owing to the geographical position of the Dundee district, which lies in the form of a crescent round the city of Dundee, with 170,000 inhabitants, and from the fact that Dundee, in addition to being an industrial town closely connected with numerous towns in the neighbourhood having populations varying from 5000 up to 20,000 inhabitants, is the port for a large tract of country extending for miles outwith Dundee, it will be readily understood that the district main roads are subjected to an enormous amount of heavy traffic. The means used for conveying goods and commodities to and from the various towns and districts are traction-engines, motor-lorries, and such like, in addition to double-horse lorries and ordinary double-horse carts. In fact, the roads are used night and day in place of the railways, which at one time commanded this traffic. Unfortunately, much of the valuable assessable area has been annexed by the city of Dundee, while the suburban traffic practically remains.

The great fact which must impress most road surveyors is that there is no lack of skill or mechanical appliances for carrying out the work of strengthening and improving the Scottish county roads, except one thing, and that is—the necessary funds. If sufficient money were available to put the main

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roads, at all events, into a good state of repair, there is little doubt that the maintenance would be simplified, as every stone put on the road afterwards would tell. At present in many cases there is only sufficient metal to keep the roads in passable order without building up a reserve of strength for emergencies.

Comparisons are made at times between districts of roads, but unless the conditions in each district are similar as regards traffic, subsoil, kind of road metal, etc., such comparisons are quite unequal. It must always be borne in mind that the foregoing remarks apply chiefly to county roads. Burgh roads can be dealt with in a different fashion, as their mileage is generally small and the financial resources greater.

DISCUSSION.

MR. M. B. McBETH: I thank Mr. Roberton for his excellent paper. Of course the prices of materials and several other points have to be taken into consideration in making comparisons and forming estimates. My Council have recently received from the Road Board a grant of 3000*l.* That means a considerable amount of extra work for the engineer and surveyor having charge of the operations, and having regard to that I would like some expression of opinion to go forth from the meeting to the Road Board as to the remuneration of the engineer engaged in the carrying out of the operations. As surveyors, we are delighted to get these grants and see the roads improved, but not when it affected us as is described. On form 18, you will find an item at the bottom of the page marked "Other expenses in which supervision, watching and lighting are to be included." A friend of mine who finished a contract a year before me included his expenses in connection with the work, and these were passed without demur; but a few months ago I had occasion to send in my own completed Form 18 in which I charged my expenses. I found it impossible to undertake my duties and carry them out to the satisfaction and credit of myself and Council, and so I have had to employ an assistant whom I have to pay out of my own pocket because no allowance was made for it. My form was rejected, and I was told that it would not be paid until the charge I made for the assistance I had obtained was deleted. Another friend of mine put a question to

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the Road Board, and in reply he was given to understand that no portion of the salary of a surveyor or a clerk of works ordinarily employed by the Council could be included in the estimates submitted to the Board. If, however, for work to which the Road Board were asked to make a grant, it was proposed to employ an additional surveyor or a clerk of works for that particular work, or to pay a surveyor or clerk of works already in the employment of the Council an additional and special fee, then the remuneration of the additional officer or the amount of the special fee might be included in the estimates. In sending up the estimate provision was made for the payment of additional assistance, and that statement was approved by the Road Board; but when we submitted our final estimate it was rejected. In my district there are 369 square miles, and the valuation is only 49,000*l.*, a 1*d.* in the £ producing only 240*l.* The first contribution was seven-eighths of the total cost of the work, which meant that if they are to carry out the work the rates of our already over-burdened district will be increased by 4½*d.* in the £. So you can understand how little the ratepayers will feel inclined to pay officials an extra salary. Under these circumstances I think the Institution should endeavour to get an arrangement made by which they could be allowed extra remuneration, providing for its payment from the Road Board grant.

Mr. R. Drummond: I rise with great pleasure to add my thanks for the paper the Author has written, giving us information of what he is doing around Dundee.

Mr. J. S. Brodie: I should like to express my pleasure in regard to this paper. The first thing that strikes me is that Mr. Roberton is experiencing what most of us are doing, that with the greatly increased use of the roads there is a corresponding increase of cost. That is the secret of the whole thing, and we shall have to meet that increase of cost in the most economical way we can. I am glad to see he is carrying out certain experiments which are in the right direction. We live by experiments in a measure, and only those who do something new can add something to the solution of this road problem. With regard to Mr. McBeth, I do not think he is any worse off than we are in England. Not only are we not allowed to receive any percentage in expending grants from the Road Board, but surveyors are not allowed any remuneration chargeable to loan. This is always a *sine quâ non*

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of all loans sanctioned by the Local Government Board. What we do is to persuade our own people to increase our salaries so as to cover the extra duties. Some of us with success, and others with not so much success. But it is considered to be a grievance by many of my English *confrères*, that if we spend thousands of pounds it is laid down by the Local Government Board that we must not benefit by that expenditure although we are spending our own authorities' money, and not money given to us by the philanthropy of the Road Board. The only way we can remedy this is to keep pegging away at our people. I commend that to Mr. McBeth. The public authorities must remember that this road problem is no light matter. It is additional expenditure caused by the additional traffic thrown upon the roads, and surely any Council must be aware that if their functions and duties are increasing the remuneration of their officials must increase *pari passu* with their expenses and duties. All you have to do is to insist upon a proper salary being paid to you. If the matter is put before them your Council will rise to the occasion, and they will see that the maintenance of roads is an increasing expenditure, and they must raise their officers' salaries to meet these additional duties. We do not ask for charity, but we want to be fairly and properly remunerated for the hard work which we put in. I am sure that every reasonable and fair-minded Council will recognise that.

MR. M. B. McBETH: I wish to point out that grants from the Road Board are not regular. Every committee would be prepared to increase the salary for work which would be regular, but it may not occur again for ten years. The committee would grudge giving an increase of salary for that, but if there were a good grant they would not mind 5 per cent. or 2½ per cent. allowance to the surveyor on the expenditure.

MR. CAMERON: We all know that this extra traffic has been thrown upon the roads, and we have got to put up with it, but the question is—who is to bear the cost? The additional expenditure on the roads is not for the residents and ratepayers. We have country roads which would meet the requirements of the district at a cost of 3*l.* or 4*l.* a mile per year, but they have to be made suitable to carry a great deal of motor traffic, and to put the road in a condition to carry that traffic may cost 1000*l.* a mile. In the County of Lanark this is a very serious matter,

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and it is coming before us every day because the motor-cars, and the heavy commercial motors on the roads are competing with the railways on every hand. Where is the money to come from?

MR. SCOTT: Dundee is a very large city, with 170,000 inhabitants, and with the surrounding district comes up to probably 300,000, which means that there is a very large traffic from the City radiating through Mr. Roberton's district, and thence on to my district. Mr. Cameron asked where the money was to come from. Lanarkshire, of all the counties in Scotland, ought to know where the money is to come from. With regard to the remarks of Mr. McBeth as to getting a commission on our work from the Road Board, I did happen to meet one of our Committee, who interviewed Sir George Gibb on that matter, and he said, while we were well received, as every one is there, we had no hope held out that we would receive anything at all from the Road Board. It was entirely left to our Committees. Mr. Brodie has carried that further forward, and suggested that we ought to keep hammering away at our Committees. But our Committees are not exactly like Mr. Brodie's Corporation may be. A great many of our members are subsisting on half what the surveyor receives. It is most difficult to approach these men on the matter of salaries. I think Mr. Roberton is proceeding carefully by starting with the strengthening of his roads, and possibly in a year or two Mr. Roberton will find it is paying him to put some bituminous binder on the roads.

MR. HAMILTON: We are here as a deputation from Lanarkshire to hear what the road surveyors and engineers have to say about roadmaking, and their upkeep and maintenance. We have had considerable discussion about this matter in Lanarkshire. Our roads are kept up, not only for our own, but for through traffic which simply passes through to Edinburgh and Glasgow, and other places, and our roads have had to be strengthened to meet that traffic. Mr. Cameron has put it to you—where the money is to come from. It is not that Mr. Cameron is in doubt whether we will get the money, but what is the proper place to get the money from? Twenty years ago our roads were made up equal to the traffic which passed over them; but a new traffic has been created, and that traffic will have to be met. Who is to pay for it? I am not here to argue

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against these gentlemen asking for increases of salary. No Council will wish engineers to work for nothing. I do expect that our engineers will give us the whole of their time, and the best of their ability, and if extra work is placed upon them we will expect them to do that work, but if it means an addition to their work we are willing and ready to pay additional salaries. But that is not the question at all. The question is the maintaining of the roads to the standard required. We have heavy motors and traction engines passing over the roads, and they ought to be taxed heavily, and then the Government ought to subsidise the County Councils for the difference it costs to maintain the roads as they are now required.

MR. J. LEE: We have had two very interesting speeches from County Councillors. It is rather difficult to understand why Mr. Cameron and Mr. Hamilton should want to know where the money is to come from. It is the duty of the County Councils to find the money, and of the surveyors to spend it, and spend it judiciously, and I have no doubt the Lanarkshire engineer is quite competent to advise them how to make the roads, and make them well, if they will find the money. All I will say is that Mr. Cameron is a very practical man, and does not require to be told how roads ought to be made. What he has to do is to make up his mind how much money is to be spent in Lanarkshire.

THE PRESIDENT: Mr. Roberton has made reference to the Telford road. I think you may take it that Telford, although he had a very definite theory with reference to a pitched foundation to his roads did not always carry that out. I had to strengthen a portion of the Shrewsbury and Holyhead road some years ago, and for miles there was no pitching at all. Telford was, like other engineers, an opportunist. It is not, therefore, correct to say that he always adhered to this pitching theory. It is true that the average English country road has not a pitched foundation at all. It is also obvious that with the funds at our disposal it is almost impossible to strengthen any great portion of the roads by taking them up and pitching. The only alternative is to go on increasing the thickness of the coating upon them. The one thing which appeals to me in the paper is the extraordinarily low price of the roads. I wish I could make my roads at anything like your price. When I tell you that a ton of granite costs anything from 13*s.* to 16*s.* per ton, you will be

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surprised to compare it with your figures. Mr. Roberton refers to pitching, and recommends that the stones should be set on edge. I do not know whether that is the practice in Scotland, but my practice is to put the flat portion of the pitching stones on the bottom, and wedge from the top, for the obvious reason that with the flatter portion of the stone on the sub-soil the less likely it is to move with traffic. I believe this is the general practice in the South of England. Reference has been made to heavy motor traffic, I am sorry to find Mr. Roberton has this difficulty to deal with. It is an anomaly that the heavy motor is entitled to travel any road in the kingdom without paying a cent tax. It is anomalous because it only applies to the heavy motor driven by steam. The heavy motor driven by petrol does contribute to the petrol tax. It is an anomaly that the heavy motor driven by steam, and a much heavier weight per inch width of tyre on roads than a traction engine, pays nothing to the cost of the highways. It is also anomalous that, while the driver of a heavy motor must have a licence to drive, which can be revoked after three offences, he can drive a traction engine without a licence. In Buckinghamshire we have put down a weighbridge to ascertain the weight of these heavy motors, and you would be surprised to know the large proportion of these heavy motors which carry loads considerably in excess of those permitted under the Heavy Motor Order. I would suggest that you should consider the question of providing these weighbridges, and compel the owners of these heavy motors to keep their loads within the law.

The vote of thanks was passed unanimously.

Mr. J. Bell Roberton, in reply: I have to thank you very much for the kind way in which you have received my paper. My one desire in this paper was to show you what we were doing locally. As brother surveyors, you will realise my position and what we are doing. With regard to many of our Scottish roads which have to carry heavy motor traffic, the first thing to do is to put in a foundation where none exists, and make them strong enough to carry the traffic. The question of putting a suitable surface on them will come in due time. With regard to Telford, and the foundation of the Shrewsbury and Holyhead road, I was quite aware that he did not always carry out his theory, but suited his ideas to circumstances. We experimented with the stones laid both ways, with the stones on

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edge, and with the stones laid in the usual way, and there was very little difference as regards wear. With regard to the statement about the Road Board, we have a difficulty in getting the money we require to strengthen the roads, but we do get some, and we try to utilise it to the best of our ability; and we trust we shall get some more. I made a claim for my services, but I am sorry to say that I did not get any compensation from either the Road Board or the County Council, but I will try again on some future occasion.

The Corporation entertained the Members to luncheon in the Victoria Art Galleries, on Friday, June 6. The Lord Provost in the Chair.

At the close of the discussion on the papers the Members were divided into three parties, and visits were made to Craigie Quarry, to inspect the tar macadam plant, the trackless trolley, Clepington Road, and the sewage pumping station, Downfield; the electricity station, the gasworks, and the saltwater baths; and the central reading rooms, central baths, esplanade, Blackness branch library, and the public washhouses.

The annual dinner of the Scottish district was held in the Victoria Art Galleries in the evening, Mr. R. J. Thomas, President, in the Chair.

On Saturday, June 7, by the kind invitation of the Corporation of Dundee, the Members visited the Dundee waterworks, the Loch of Lintrathen, and Glamis Castle. The party were conveyed in motor-cars to Lintrathen, where the works were inspected, and the party were entertained to lunch by the Corporation. Baillie Forwell presided. On the return drive a visit was paid to Glamis Castle.

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NORTH WESTERN DISTRICT. MEETING AT ROCHDALE.

June 14, 1913.

Held in the Town Hall, Rochdale.

R. J. THOMAS, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Members were received by the Mayor (Alderman W. Cunliffe, J.P.), who offered them a most hearty welcome to the town.

The President thanked the Mayor for his kind welcome.

The following paper was discussed.

ON SOME OF THE MORE RECENT MUNICIPAL WORKS OF ROCHDALE.

BY S. S. PLATT, M.INST.C.E. (*Member*),
BOROUGH SURVEYOR, ROCHDALE.

THIS meeting is intended primarily as a visit to some of the works carried out by the Author since the last visit of the Institution in 1897, and the following description is offered to explain the principal features of interest to Members, rather than that of a paper for discussion.

In Vol. XXIII. (1897) of the Proceedings was given an account of some of the Chief Municipal Works of Rochdale at that date, viz. the Town Hall, Technical School, Free Library, New Fire Station, Sewage Disposal Works, and an interesting sewer crossing under the Rochdale Canal.

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To recapitulate shortly for the benefit of Members who do not possess Vol. XXIII. or the "Surveyor" of May 28, 1897, containing the description of the Sewage Disposal Works in 1897. The sewage, then about 1¼ million gallons per day dry-weather flow, was passed through a detritus catch pit and screening chamber, after which alumino-ferric was added, and when necessary sulphuric acid to neutralise the excessive alkalinity due to flushes of Wool Scouring Trade Refuse. The sewage then passed through one of two roughing tanks, each having a capacity of 105,000 gallons, then through six precipitating tanks each of a capacity of 200,000 gallons, total capacity of tanks = 1,410,000 gallons. The tank effluent was then passed on to twenty-four land filtration plots having a total area of 60 acres. The final effluent from the land was discharged into the River Roch at six outlets. The precipitated sludge was pressed in four presses, since increased in 1908 to six, and improved by new mechanical arrangements for opening and closing.

The amount of pressed sludge 1912–13 was 4050 tons.

Extension of the Sewage Disposal Works, Roch Mills (1913).

Plate I. Owing to the abnormal foulness of the sewage and the increased volume now delivered to the works caused by the coupling up of districts which were not connected to the main sewers of the borough, the land proved to be inadequate for dealing with the sewage in a satisfactory manner, and the surface of the land filtration plots became coated over with sludge from the tank liquor, causing the water to lie in lakes on the plots, and an unpleasant odour to be given off when any of the plots were "dried off." In 1901 the Author presented a report dealing with this matter, and advised a scheme to be carried out, including an installation of percolating filters for the treatment of the major portion of the sewage and to act as a relief to the land. Owing to various causes this portion of the scheme was not carried out, but the whole of the land was rested and re-levelled where necessary, deep ploughed and cropped, and the sludge on the surface was disposed of. Also 5½ acres of contact beds were constructed out of rates, at a cost of about 6500*l*., and have since been used to supplement the land in dealing with the sewage. This subsequently proved to be only a temporary relief, and as no more suitable land available for the purpose

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was to be had in the neighbourhood or even for a considerable distance, the Author again advised that it was only possible to look for means of improvement in bacterial beds as a supplement and relief to the existing arrangements.

In regard to the foulness of the sewage previously referred to, the Royal Commission on Sewage Disposal, in the 3rd Appendix to the Fifth Report issued in 1909, at p. 450, state that "The above figures show the Rochdale sewage, as judged by the hourly samples, to be very strong, especially in oxidisable matter," and, after giving further particulars, conclude as follows: "Nothing more requires to be added to emphasise the foul and greasy character of Rochdale sewage." It may be interesting to mention that in September, 1899, two experimental percolating filters, having an area of 400 square yards 9 feet deep of gas coke, 1½-inch gauge and upwards, were installed on "Whittaker and Bryant's" principle, and have been worked continuously since that date up to the present with varying quantities of both septic and chemically precipitated sewage effluent, and within that time the Royal Commission paid two official visits to the Works, and the officers of the Commission paid frequent visits of inspection, and made analyses of many samples of effluents from these beds under varying conditions of working. Ordinarily the filters were worked at a volume of 133 gallons per cubic yard per twenty-four hours, but at the request of the Royal Commission this volume was in the case of chemically precipitated effluent gradually increased up to 250 gallons per cubic yard, when their tests were discontinued, the results of which it is expected will appear in a subsequent report.

As the result of the satisfactory continued working of these experimental filters, and also the successful working of an installation since 1905 of six similar filters at a branch sewage works in the southern part of the borough at Castleton, the Author in May, 1910, submitted a complete scheme of extension and alterations which, in his opinion, were necessary for the satisfactory disposal of the sewage tributary to the Roch Mills Works.

In order to comply with the requirements of the Local Government Board it was necessary that provision should be made for three times the dry-weather flow of sewage to be treated as sewage, and that an additional volume of three times the dry-water flow should be treated as storm water. The recommendations of the Royal Commission having included in

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their Fifth Report the dealing with the storm water in special settling tanks, the Author designed the scheme accordingly.

The sewage tributary to these works was discharged at two outfalls at opposite sides of the farm, and the ordinary dry-weather flow at both outfalls was about 2¼ million gallons per twenty-four hours, but for the purpose of the scheme the total dry-weather flow was taken at 2¾ million gallons to allow for anticipated increase at an early date due to extension of the main sewerage system, and for increase expected from conversion of pail closets to the water-carriage system, and this would make a volume of 8¼ million gallons of sewage to be treated as sewage, and an equal volume of diluted sewage to be treated as storm water. It should be mentioned that heretofore the flow of sewage tributary to the minor outfall (the Sudden Valley)—about 500,000 gallons per day—was treated in a set of three precipitating tanks of a total capacity of 300,000 gallons, and the extension scheme provides for utilising these existing tanks for treatment of the storm water only due to that outfall, and diverting the sewage up to three times the dry-weather flow by a new line of pipes to the main works, so as to enable the whole of the sewage flow from both outfalls to be screened and dealt with at the Roch tanks, and for this purpose the inlet arrangements at main works have been altered and the provision made in duplicate of new entrance channels, detritus catchpits, screens, chemical mixing channels, etc. In order to increase the tank capacity it is proposed to construct an additional tank adjoining the No. 6 of the Roch tanks, with a capacity of 200,000 gallons, which, added to the existing tank capacity of 1,410,000 gallons, will give a total tank capacity of 1,610,000 gallons, or equal to rather more than fourteen hours' flow of the dry-weather sewage.

After having undergone chemical precipitation whilst passing through the tanks, the tank liquor drawn off at either end of the tanks, to the extent of 450,000 gallons of the daily dry-weather flow will be dealt with on 45 acres of the land already laid out for filtration, after it has been re-levelled where necessary, cropped to take off the sludge, and deep ploughed and sub-soiled; the remainder of the dry-weather flow (2,300,000 gallons) will pass by gravitation through a new pipe line under Roch Mills Lane and over the River Roch to a pump well situated at the westerly side of the farm, on each side of which

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will be placed the installation of percolating filters to treat the major portion of the tank liquor. As the top of the filters is above the level of the tanks it was necessary to provide for the requisite pumping plant, to house which has been erected a building adjoining the pump well previously mentioned, and in which has been installed centrifugal pumps driven by electric motors. Each pump unit is capable of delivering 3,450,000 gallons per day into an overhead tank adjoining the pump house. This tank is elevated sufficiently to feed by gravitation the automatic revolving sprinklers for distributing the tank liquor on the surface of the filters.

In order to safeguard against a breakdown, and to comply with the requirements of the Local Government Board, a "stand-by" electrically-driven pumping plant is provided, as continuous pumping will be necessary in order to deal with the sewage flow to the works. As previously mentioned, it is intended to treat the tank liquor so pumped on lines based on the results of the two experimental beds at Roch Mills, continuously worked since September, 1899, and on similar lines to the installation constructed in 1905 at the Castleton Sewage Disposal Works.

The scheme provided for the laying down of twenty-three percolating filters each 72 feet diameter, 9 feet deep, with a surface area of 452 square yards. The quantity of tank liquor treated was proposed to be at the rate of 220 gallons per cubic yard per twenty-four hours during the time that the greatest volume has to be dealt with, and at the rate of 73⅓ gallons per cubic yard per twenty-four hours during the time that the smallest volume has to be dealt with. The Local Government Board, as a condition of giving their sanction, reduced the volume to be treated on these filters to 65 gallons per cubic yard for dry-weather flow and 195 gallons for three times diluted flow, the result being that the number of filters had to be increased from twenty-three to twenty-six. These are to be in two groups, thirteen being placed on each side of the pump house, the first half having been constructed and brought into use and the remainder to be constructed within a short period after this first installation has been brought into operation.

The floor of the filters has been constructed of cement concrete, rendered smooth and made to fall to channels provided for the collection of the effluent. The outside walls of the filters

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are constructed of pigeon-holed brickwork, and a false bottom is formed by means of 15-inch diameter perforated half pipes, upon which is placed the filtering material, consisting of gas coke (obtained from the Corporation Gas Works) which has had all smaller than 1½ inch taken out of it. In the centre of each of the filters is a shaft of brickwork, on the top of which rests the body of the sprinkler for distributing the tank liquor, consisting of six revolving arms of iron pipes, perforated at varying distances so as to insure a uniform distribution over the whole of the upper surface of the filter.

After the tank liquor has passed through the filters it flows by means of channels to the humus tanks, two in number, each of a capacity of 225,000 gallons, through which it is allowed to pass slowly and deposit as much as possible of the heavier portion of the fine solid matters that are in suspension.* These tanks are provided in duplicate so that they can be cleaned out alternately, the top water being run off into the pump well, and then retreated on the filters; the deposited matter in the form of very thin sludge gravitating to a sludge well adjoining the pump well, from which it is pumped by a centrifugal pump through a 6-inch sludge main to the new Sudden outfall, to mix with the sewage treated at the tanks. Arrangements have been designed that the filter effluent having passed through the humus tanks can, if necessary, be dealt with on the adjoining fine ash beds, 2½ acres (now used as secondary contact beds), when they have been converted by a different arrangement of feed into streaming filters.

Pump House Buildings and Plant.

Plate No. 2. These are situate midway between the two stacks of percolating filters, the one already constructed and the one included in the full scheme, and opposite the south end of the humus deposition tanks. The buildings are one storey in height above ground, finished in Accrington facing bricks with Yorkshire stone dressings. They comprise a pump room, 40 feet by 24 feet; men's mess room, 19 feet by 18 feet; store and repair room, 18 feet by 15 feet, with lavatory, etc., and heating chamber in cellar; also tank effluent well (pump well), 40 feet by 20 feet, with overhead delivery tank of the same dimensions, and a sludge well, 24 feet by 15 feet. The rooms internally are finished in

* The final effluent passing to the River Roch.

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Accrington facing bricks, with glazed brick dado in pump house. The tank effluent is delivered to the pump well through a 3-feet diameter cast-iron pipe, which has a larger discharge capacity than required, but acts as additional storage in conjunction with the pump well.

The well is built of brickwork in cement, lined with "Breala" asphalte put on in two coats, and supports the overhead delivery tank, 3 feet 3 inches deep, the floor of which is in reinforced concrete 9 inches thick, both floor and sides being lined with asphalte. The floor of this tank gives a head of one foot above the level of the top of the percolating filters. The whole of the plant installed for pumping the tank effluent from this well to the overhead delivery tank which commands and feeds the percolating filters has been supplied and erected by the Rees Roturbo Manufacturing Co., Ltd., of Wolverhampton. It consists of four electrically driven centrifugal pumps of their Roturbo pressure-chamber type, each directly coupled to a semi-enclosed direct-current motor of their own manufacture. The plant is arranged in two full units and two half-units. Each full unit can lift 3,450,000 gallons in 24 hours (or at the rate of 2400 gallons per minute) to a height of 14 feet 6 inches, which is the ordinary working lift. Any two full units are capable of pumping the maximum flow to be treated on the percolating filters, viz. 6,900,000 gallons per 24 hours, the remaining unit being provided as a "stand-by" in case of breakdown. The half-units are provided to deal with the reduced night flow, and with the variations of the ordinary flow. It should be noted that the plant is of sufficient capacity for the full scheme, which includes an additional thirteen percolating filters. All the pumps have "drowned" suction pipes, the sizes of the suction and delivery pipes of the full units being 12 inches diameter, and of the half-units 9 inches diameter. The full units have 20 B.H.P. motors, and the half-units 10 B.H.P. motors.

For dealing with the "humus" from the deposition tanks, which flows by gravitation into the sludge well previously mentioned, a pump of similar type to the other pumps has been installed, with 6 inches diameter suction and delivery pipes, driven by a 10 B.H.P. motor. In this case the pump is not "drowned," but is primed from the tank effluent pump well. This pump raises 300 gallons per minute of sludge against a total head of 42 feet. This humus sludge, containing 95 per

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cent. of water, is delivered into the Sudden Valley outfall main, and so passes along to the main works for treatment.

All the arrangements for the starting gear, switches, meters, etc., are on two switch-boards, fixed on the control platform, 8 feet above the floor of the pump house, and on the same level as the floor of the men's room, etc., thus giving easy access for the men in charge.

The switch-boards are of slate slabs, mounted on an angle-iron frame, with polished teak casing. There are panels for the incoming main supply, lighting circuits, circuit to the Sudden storm-water screen motor, together with a separate control panel for each pump motor, each panel being fitted with a protected, enclosed, ventilated type of starter, circuit-breakers, fuzes, meters, &c.

The electrical work has been executed by Messrs. Whipp and Bourne, Rochdale. The buildings and the percolating filters, etc., are lighted by incandescent electric lamps, work carried out by the Rochdale Electric Co., and the pump house has an installation of low-pressure hot-water heating on the "Reck" system, supplied by Messrs. Saunders & Taylor, of Manchester. The electrical supply is direct from the Corporation power station, and is a three-wire system of 440 volts between the outers and 220 volts between each outer and the middle wire; but the installation has been designed in such a manner as to allow of the overhead lines being supplied at 550 volts from a traction supply, of which the negative will be earthed. The portion up to the old works has been laid underground by the Corporation departments, to a connection board in the engine house, about 1200 yards, and thence overhead forward over the Settling Tanks, supported on steel lattice standards, and over the farm on "A" wooden poles to the switchboard at the pump house, about 560 yards, and to subsidiary plant at the Sudden screening chamber, etc., about 240 yards.

The supply of cable and all overhead work has been carried out by Messrs. Glover & Co., of Manchester.

The electrical part of the scheme, including the work at the pump house, has been designed and supervised by the Borough Electrical Engineer, acting in co-operation with the Author.

Weir-gauging recorders and water-level indicators have been provided in different parts of the works where required, supplied by Messrs. Geo. Kent, Ltd.

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Having described the plant provided for the disposal of the sewage up to a volume equal to three times the dry-weather flow, as previously mentioned, now follow the particulars of the provision for treating an equal volume of storm water.

Following the recommendations of the Royal Commission in their Fifth Report, the scheme provides for two settling tanks having a total capacity of 515,000 gallons = 6 hours flow of sewage delivered by the main outfall. This diluted sewage before reaching the storm overflow weir has passed through detritus catchpits and the mechanically operated screens at the entrance to restrain the grosser solids, and the overflow only from the storm-water tanks passes to the river. The contents of the storm-water tanks after the end of the storm flow and after settlement are drawn off by floating arms down to the sediment, and flow to an effluent well at the original works, and are pumped up to the channel for treatment in the precipitation tanks, and any sediment is separately drawn to the sludge well for treatment along with the sludge from the precipitation tanks. The same arrangements are carried out at the Sudden storm-water tanks. Supernatant water left in these tanks is passed over a filtration plot adjoining, and the sediment is forced by a Shone's ejector to the main works for treatment along with the sludge tributary to that works. In this case, however, the storm flow is screened by a motor-operated screen on similar lines to that installed at the main works hereafter described before passing to the storm-water tanks.

CATCHPITS, SCREENING AND CHEMICAL MIXING PLANT.

Plate No. 3. At the entrance to the works there are three catchpits (30 feet by 8 feet), after which the sewage passes through two (or if necessary in times of storm through three) screens. As the screening and raking apparatus at these works supplied by Messrs. S. S. Stott & Co., Engineers, Haslingden, possesses novel features, the author has thought it advisable to insert here a full description of it.

The three screening and raking apparatus (Law's patent) are fixed in chambers 8 feet wide by 6 feet 9½ inches deep at the outlet end of the detritus tanks. Each inclined screen is fitted with taper section steel bars 7 feet 6 inches long, spaced ½ inch apart, the maximum sewage level being about 5 feet. The raking gear above the coping consists in each apparatus of a

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built up steel framework with sprocket wheels and bearings, also malleable detachable chains, carrying a travelling-cleaning rake fitted with a series of malleable prongs. The rake is suspended by two vertical "T" section arms from a cross-bar on the chains, and is counterbalanced by two weights suspended by wire ropes working over suitable groove pulleys. The ends of the rake are fitted with runner pulleys, working between cast-iron guides in front of the inclined screen. In working, the rake descends through the channel guides furthest from the screen, and ascends through the guides nearest to the screen, the prongs engaging in the spaces between the screen bars and removing the refuse therefrom. A vertical steel plate is fitted at the top of the screen to prevent the refuse falling from the rake, and on the rake arriving at the highest point of travel the refuse is automatically discharged by a cleaner, consisting of a set of vertical prongs in a cross-bearer, actuated from the detachable chains which carry the rake. At the junction of the "up" and "down" guides a hinged flap is fitted, to ensure the rake descending the guides furthest from the inclined screen.

Conveyor.—A scraper conveyor, consisting of a series of steel scrapers on a double-strand endless chain, working along a steel trough, removes the screenings and deposits same into a wheelbarrow at the side of the screening chambers. The three screening apparatus and the scraper conveyor are driven independently by means of steel roller chains and sprocket wheels with clutches, from a countershaft across the tanks, the motive power being obtained from a totally enclosed motor, 9 B.H.P., 1070 r.p.m., direct coupled to a set of worm reduction gearing to transmit 6 B.H.P. at 40 r.p.m.

Crane.—The jib crane for raising the detritus in a wheelbarrow from the tanks, has a radius of 18 feet, and is suitable for lifting loads up to 10 cwt. The crane is operated by hand, but is arranged so that an electric motor can be applied if found desirable.

Chemical Boxes.—Immediately in front of the agitators, in the two sewage channels, are two chemical boxes, each consisting of a perforated steel trough 7 feet 4 inches long, containing the alumino-ferric, the troughs being carried by link chains working over suitable winding barrels, with spur and pinion gear for raising and lowering by hand.

Agitators.—The two agitators are of the double type, each

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having two vertical shafts with horizontal agitator arms, geared to work in opposite directions by means of bevel gear and cross shaft. The lower end of each of the four vertical shafts is supported in a footstep bearing, the top end of each shaft being carried in a cast-iron cross bearer. All the bearings for the vertical shafts are bushed with gun-metal. The cross shaft extends across both channels, and is supported by pedestals with double gun-metal steps. The bevel driving wheels are each fitted with a sliding clutch with hand levers so that any of the four revolving agitators may be stopped or started independently of the others. The agitators are driven by a totally enclosed motor 4 B.H.P., 1000 revolutions per minute, direct coupled to a set of worm reduction gear, to transmit 3 B.H.P. at 40 r.p.m., with a steel bushed roller drive chain, and sprocket wheels with machine-cut teeth, to transmit power from the worm gear to the cross-shaft of the agitator.

The screening apparatus at the Sudden Valley Sewer is of exactly similar type to the three described for the Roch Mills screening chambers, the depth in this instance being 5 feet 8 inches. This apparatus is driven by a $2\frac{3}{4}$ B.H.P. motor with worm gear to transmit 2 B.H.P.

The whole of the constructional work of the extension has been carried out under contract by Messrs. J. Bentley & Co., of Bradford, the penstocks and other sewerage ironwork being supplied by Messrs. J. Blakeborough & Sons, of Brighouse; cast-iron pipes, and specials by the Staveley Coal and Iron Co.; Messrs. Rd. Johnson, Clapham, and Morris of Manchester have supplied the wire netting for reinforcing brickwork and foundations, and the Expanded Metal Co. the reinforcement in concrete. The whole of the rotary sprinkler apparatus (mercury seal), including all piping, valves, etc., connected therewith has been supplied and erected by Messrs. C. Whitaker & Co., Ltd., of Accrington. The total cost of the extension work now carried out is about 32,000*l*.

As the extension works are only just about approaching completion it is not possible to give any results of sewage treatment in respect to them, but it may be of interest to give the results of the experimental filters previously referred to, upon which the scheme has been based. It should be mentioned that the sewerage tributary to these works is on the combined

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system with storm overflows, and the average flow to the works during the last three years has exceeded the normal by from 50 per cent. to 70 per cent. according to the wetness of the seasons.

AVERAGE RESULTS FOR THE LAST THREE YEARS IN GRAINS OF OXYGEN ABSORBED PER GALLON IN FOUR HOURS, WHEN DEALING WITH 133 GALLONS OF PRECIPITATED SEWAGE PER CUBIC YARD OF FILTER.

Raw sewage.	Tank effluent going on experimental percolating filters.	Effluent leaving experimental percolating filters.	Effluent leaving small Humus deposition tanks.
9·02	3·87	1·22	0·66

The second part of the installation required to complete the scheme is the duplication of the outfall sewer, as the present 30-inch iron outfall executed in 1886, is only capable of delivering about 4¼ times the present dry-weather flow, and only about 3½ times the flow proposed to be provided for, and it will therefore be necessary to construct an additional outfall sewer alongside the existing one, for a length of about 870 yards to the Roch Mills works. There will also require to be constructed an additional tank adjoining the No. 6 tank at the main works, and the second installation of percolating filters on the easterly side of the pump house. (This work is stipulated by the Local Government Board to be completed by May, 1915.) The estimated cost of the second installation is about 22,000*l.*

WORKS IN FERRO-CONCRETE.

There seems a tendency for the universal reign of steel to be giving way somewhat to a return of masonry construction—not to brick or stonework, but to an artificial stone, *i.e.* concrete strengthened by steel. This composite material of construction is variously called "ferro-concrete," "concrete steel," "armoured concrete," "fortified concrete," "reinforced concrete," and many others, at the whim of the patentee or advocate using some variety or method of union of the two materials of which it is composed. Concrete itself is not a new constructional material, for the Author remembers, when visiting Rome over thirty years ago, noticing ample evidence of its use early in the present era. Concrete alone, however, is comparatively weak when exposed to tensile strains. Its use has been limited to cases where only a low tenacity is called for, but, by the combination

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with steel, in which the steel is rigidly embedded in the concrete, the concrete stiffens the steel, and the steel reinforces the concrete, thereby producing a constructional material of great value, economic adaptability, and usefulness. An important consideration is that, once properly made, the first cost is the only cost—a great advantage over steel construction, which, if exposed to atmospheric influences, requires a constant outlay for maintenance. In order to attain successful application of this combined constructional material, it is, however, absolutely necessary that the work should be entrusted only to persons properly qualified to settle the proportions and distribution of the reinforcement; and the work must be carried out under qualified supervision by contractors experienced in this class of work. Any departure from or non-observance of the essentials of first-class work considerably reduces the strength of this most valuable constructional material in a manner which cannot be determined by calculation.

The Author does not propose to enter into the many matters affecting the design, construction, and stability of reinforced concrete, which can now be more fully studied to advantage in text-books and periodicals devoted specially to this new form of construction, but *en passant* he may refer to special matters of detail which he had to deal with in the work hereafter described, as it is probably known to some of you that he was one of the earliest in this country to adopt ferro-concrete construction, and some of the work presented unique points which he trusts will be of interest to his fellow-members. The four works hereafter described were carried out on the "Hennebique" system of ferro-concrete.

(*a*) Two arch bridges, each 23 feet 6 inches span, to carry a new street, 15 yards wide, called Mellor Street, over the river Spodden. (Completed 1905.)

(*b*) Covering the river Roch in the centre of the town for a length of 100 yards by a width of 20 yards, to form a central open space for a distributing centre of a system of electric tramways for the borough and surrounding districts. (Completed 1905.)

(*c*) An arch bridge 8¾ yards span and 14 yards wide between parapets to carry Milnrow Road over the Rochdale Canal at the borough boundary at Firgrove to replace an old narrow and inconvenient arched bridge 7 yards span and 4½ yards wide between

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parapets, erected about 1800, when the canal was originally made. (Completed 1906.)

(*d*) A further covering of the river Roch for a distance of 45 yards below the Rochdale bridge and below the work (*b*) previously referred to, in connection with the construction of a new street 16 yards wide, and to enable an isolated tramway to be connected to the centre. (Completed 1909.)

In connection with these works the Author deemed it essential that special precautions should be taken in the use of a new material of construction about which there was then very little experience in this country, and it may be of interest to record the following matters of importance. The aggregate was determined by the Author to be of "Lonkey" rock, which is a local hard fine grit stone forming the hardest and most solid beds of the Haslingden grit of the Millstone grit formation. The gauge to be of all sizes from $\frac{3}{4}$ inch down to $\frac{1}{8}$ inch, and it was to be broken as cubical as possible. In most stone-breakers there is a liability for such hard grit stones to be broken into a flaky shape as distinguished from the cubical. This depends somewhat upon the make of the breaker and the arrangement of the crushing jaws, which, instead of knapping, have a tendency to shear the stone off in flakes. These would probably pass edgeways through an ordinary wire riddle, and therefore be larger than the prescribed gauge, which should be objected to, otherwise they will cause voids in the concrete (which should be guarded against) by lying flatwise across the steel reinforcement. Another important point is as to the amount of dust, or flour, in the resultant crushed stone—which, if of an earthy character, would considerably deteriorate the strength of the concrete by taking up and so diluting the amount of cement compo in the mixed aggregate. From experiments made for the Author with one part of G. & T. Earle's cement to three parts of various kinds of sand, as follows: (1) The fine riddlings from the crusher of Lonkey or hard flagrock stone; (2) the same, with the floury dust washed out; (3) ordinary sharp pit sand, mostly quartz grains; (4) Millstone grit sand, ground in a mill; and (5) Standard Leighton Buzzard sand—the following results were obtained:—

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TABLE OF TESTS OF SAND AND CEMENT BY MESSRS. HENRY FAIJA & CO.
In all cases the average of three briquettes, September, 1903.

Briquettes (1" section), and cubes, were composed of three parts by weight of each of the sands to one part of G. & T. Earle's cement.	Seven days.	Fourteen days.	Twenty-eight days.
TENSILE STRENGTH PER SQUARE INCH—			
Strain applied at the rate of 100 lbs. in 15 seconds—			
No. 1.—Crushed Lonkey sandstone (sand used as received)	lbs. 262	lbs. 279	lbs. 373
No. 1a.—Crushed Lonkey sandstone (sand washed before gauging)	364	427	497
No. 2.—Natural sand	302	381	413
No. 3.—Crushed yellow gritstone	290	339	397
No. 4.—Standard Leighton Buzzard sand ..	351	—	—
CRUSHING STRENGTH PER SQUARE INCH—			
No. 1.—Crushed Lonkey sandstone (sand used as received)	2405	2434	3168
No. 1a.—Crushed Lonkey sandstone (sand washed before gauging)	3872	3989	3578
No. 2.—Natural sand	3226	3285	3490
No. 3.—Crushed yellow gritstone	2199	2640	3285
No. 4.—Standard Leighton Buzzard sand ..	2933	—	—

NOTE.—Washing the Lonkey (No. 1 to 1a) got rid of about 30 per cent. of fine dusty matter passing through a No. 100 sieve (see following Table) :—

TABLE OF TESTS OF CEMENT AND SAND BY MESSRS. HENRY FAIJA & CO. FOR FINENESS, SEPTEMBER, 1903.

Sample described as :	Residue on sieves numbers.				
	100 × 100	76 × 76	50 × 50	25 × 25	10 × 10
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Cement	0·6	Trace	Nil	—	—
No. 1.—Crushed Lonkey sand (unwashed)	64·0	60·0	58·0	46·0	24·0
No. 1a.—Crushed Lonkey sand (washed)	98·0	96·0	90·0	78·0	50·0
No. 2.—Natural sand	97·0	86·0	60·0	20·0	12·0
No. 3.—Crushed yellow sandstone	70·0	58·0	36·0	12·0	0·6

The Author would here draw attention of members to a series of comparative tests of the effect of "Rock flour" in concrete, recorded in "Concrete and Constructional Engineering," of May 1912, pp. 369–371, in corroboration of the earlier tests made for him.

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The proportion of the aggregates specified and used was :—

		Parts by measure
27	cube feet of broken stone =	3⅓
13½	„ „ of sand =	1⅔
		5
8¼	„ „ (or 6 cwt.) of Portland Cement	1 = 5 to 1.

These quantities when properly rammed yield about 31 cubic feet of concrete. It may also interest you to have the comparative results of tests of columns, of plain concrete and ferro-concrete 3 feet long by about 12 inches by 10 inches rectangular, made at the same time and from the same mixtures of concrete as used in the work.

Test number.	Material.	Age in weeks.	Dimensions.	Cracking stress.	Crushing stress.
				Tons per sq. ft.	Tons per sq. ft.
5950	Concrete 5 to 1	9	12″ × 9·9″ × 36″	60·1	60·1
5951	Ferro-concrete 5 to 1 4 steel bars 1·77″ diameter held in position by wire rods 0·20″ diameter twisted round same in seven places	9	11·8″ × 10·3″ × 36″	210·5	240·9
(Tests made by Messrs. D. Kirkaldy & Son, London, January, 1904)					
542	Concrete 5 to 1	52	10″ × 12″ × 36″	113·6	113·6
553	„ „	53	10″ × 12″ × 36″	117·8	117·8
21	„ „	53	10″ × 12″ × 36″	141·0	141·0
548	Ferro-concrete 5 to 1	52	10″ × 12″ × 36″	176·2	220·8
550	„ „	54	10½″ × 12″ × 36″	183·2	219·3
551	„ „	53	10½″ × 12″ × 36″	183·2	208·9
24	„ „ (Transverse links twisted)	58	10″ × 12″ × 36″	211·0	343·0
(Tests made at the Municipal School of Technology, Manchester, November, 1904.)					

The tests Nos. 21 and 24 are referred to in Mr. W. C. Popplewell's paper in the "Proceedings Inst.C.E.," vol. clxi. (1904–5), p. 328.

Mellor Street Bridges.

Plates Nos. 4 to 8. In the case of the two arched bridges carrying this new street over the River Spodden the special reason

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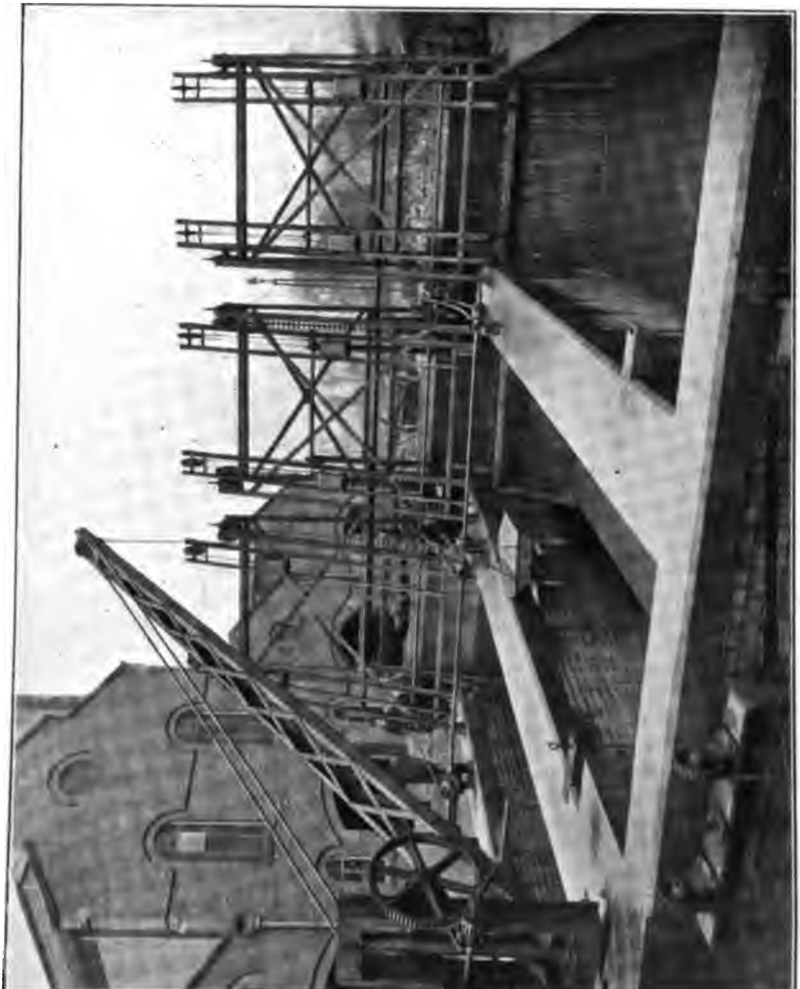

Catch Pits, Screen and Chemical Mixing Plant.

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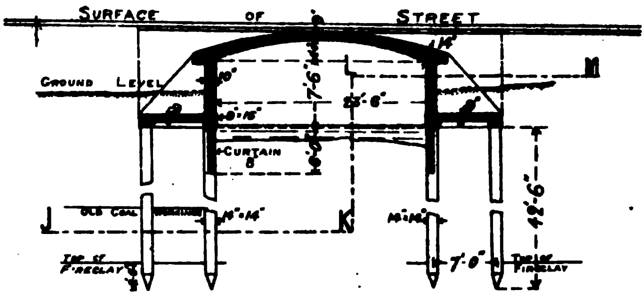
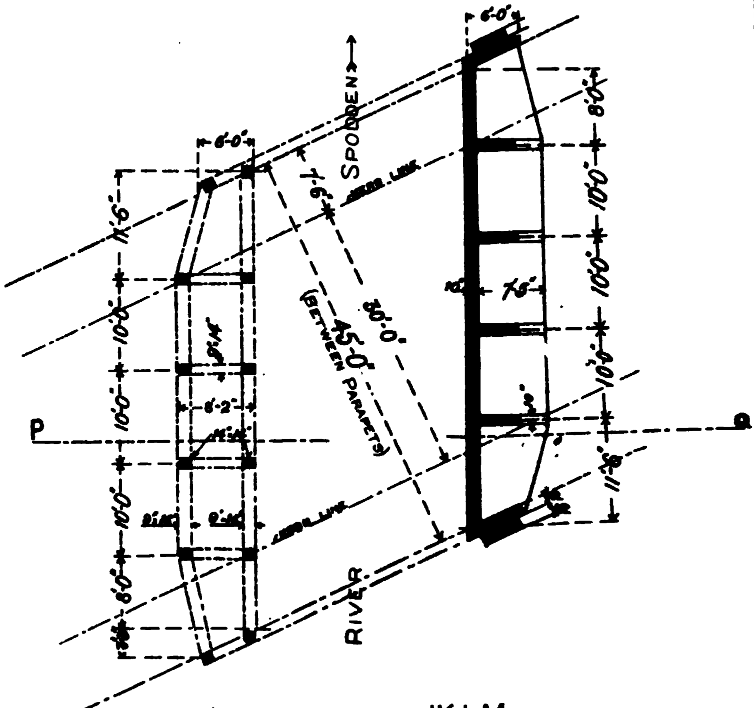
MELLOR STREET BRIDGE.

ROCHDALE.



SECTION PQ.

SCALE OF FEET.



SECTIONAL PLAN JK,LM.

PLATT, ROCHDALE.

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TE VI.

THIS ILLUSTRATION SHOWS ONE OF THE FERRO-CONCRETE ABUTMENTS NEARING COMPLETION.

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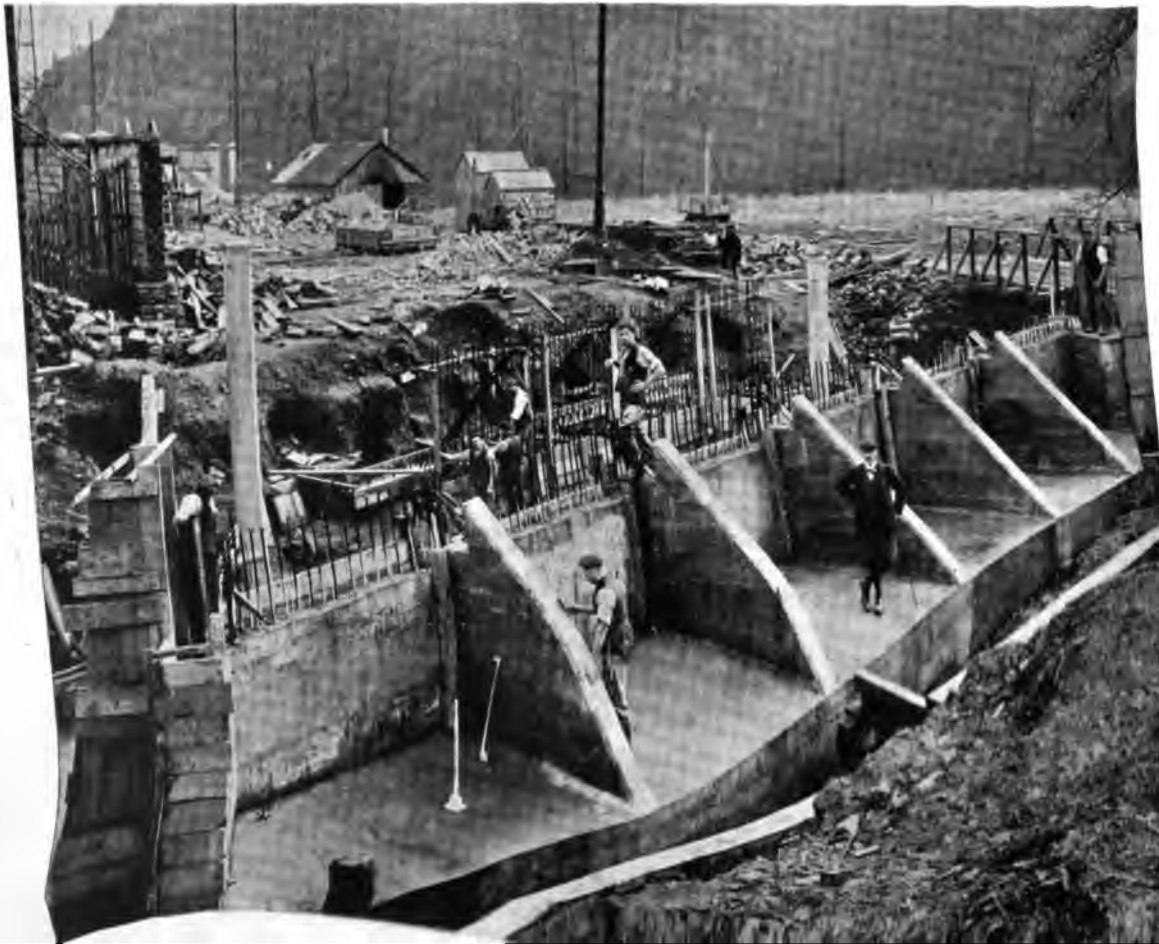
MELLOR STREET BRIDGES, ROCHDALE.



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MELLOR STREET BRIDGES ROCHDALE.

CONSTRUCTION OF ARCH IN FERRO-CONCRETE.

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MELLOR STREET BRIDGES, ROCHDALE.

COMPLETED BRIDGE. Span—23·5 feet. Width of Roadway—45 feet.

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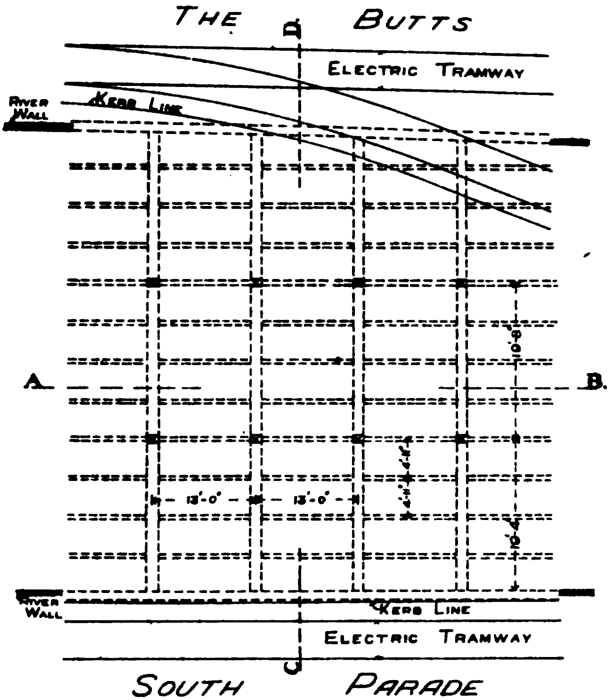
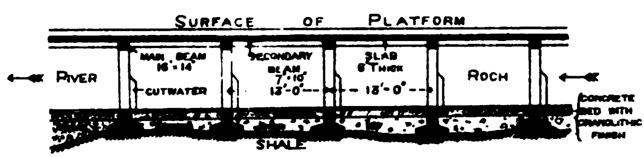
RIVER COVERING, ROCHDALE.

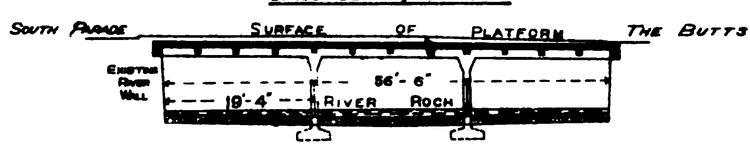
Part Plan of Covering



Longitudinal Section on A.B.



Cross Section on C.D.



Scale of Feet.

Platt, Rochdale

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COVERING IN THE RIVER ROCH, ROCHDALE.

VIEW DURING CONSTRUCTION OF THE FLOORING.

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COVERING OF THE RIVER ROCH, ROCHDALE.

View from the River Bed, showing the Ferro-Concrete Columns and Beams under the Flooring.

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Tramway Depôt, Rochdale.

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for the adoption of ferro-concrete construction was the abnormal difficulties due to the presence of colliery workings in the Royley or Arley Mine of the Middle Coal Measures (at least 4 feet in depth) under their sites, at a shallow depth of 30 to 40 feet below the river level. These workings contained water which was being pumped out and used for industrial purposes. To rest a bridge on land so badly honeycombed would have been to court disaster. The scheme consisted of boring cylindrical holes, 16 inches in diameter, through the shale overlying the disused coal workings, down to the fireclay under the coal; then pitching ferro-concrete piles, 14 inches square with corners bevelled off, 40 to 50 feet long, in such boreholes and driving same at least 2 ft. 6 ins., into the fireclay, and so that they should have a set, after three blows with a 30 cwt. monkey dropped 5 ft. 2 ins. of not more than ½ inch, which would give a resistance equal to a dead load of about 90 tons on each pile. Upon these piles which are arranged in each abutment in two rows approximately parallel about 10 feet apart centres (one bridge has 12 and one 14 on each side of the river) is placed a ferro-concrete slab, 9 inches thick, upon which rests the abutment, 10 inches thick, supported by a buttress 10 inches thick at every back pile, and at the springing the abutments are further strengthened, thickened, and reinforced to resist the pressure of the arch, and tendency to rupture at that point. The arch is 9 inches thick at the crown and 14 inches at the springing, with a rise of 2 feet above the springing line. The steel rods in every part are combined into the adjacent portions, and overlapped at every junction so as to ensure a completely connected and homogeneous structure. Owing to the plan of the bridges being on the skew the upper set of rods for the extrados for a distance of about 10 feet in one case to 14 feet in the other from each side were laid diagonally across the rods for the intrados parallel with the parapets. The rods in the slab were disposed as required in ferro-concrete beams, in the abutments as in walls. Below the level of the slab, the underside of which was about 5 inches above the ordinary water level in the river, there was arranged, in line with the front of the front row of piles, a curtain wall 8 inches thick to prevent scour of the bank below the slab and behind the arch, and this curtain wall was carried low enough to allow for a considerable margin of alteration in the bed of the river, which may arise in the future due to the possible abandonment

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of adjoining weirs. In six cases the piles did not give the required set and had been driven so near to water level, that it was necessary to lengthen them, this was done by breaking away about 18 inches of the concrete at the top, extending the rods through coupling pieces of iron tube about 2 feet long, extending the shuttering say 10 feet, and so lengthening the pile to that extent of 4 to 1 concrete. After allowing the concrete to set for about a month these piles were again driven without damage until the required set was obtained, and any superfluous length was then sawn off. In one case owing to some of the shale dropping into the borehole, a pile could not be driven to the foundation required. After trying to drive it for 24 hours, and it could not easily be withdrawn it was decided to abandon any dependence upon it, and by driving the piles on each side of it until a set of ¼ inch in three blows was obtained and providing extra steel reinforcement in the abutment so as to cantilever it over the abandoned pile the work was proceeded with.

These bridges were the first in this country constructed of ferro-concrete from the foundations to the super-structure, and they are also the first which have been built with slab arches, that is, arches without ribs or beams. The parapets were formed of Stanicliffe stone from the quarries near Rowsley, Derbyshire, and were designed with perforations to give a neat and light appearance. These bridges were very carefully and severely tested, the following being the method adopted : The heaviest load likely to pass over the bridge was a Lancashire boiler weighing, say, 25 to 30 tons, and this would be carried on two bogies spread over a long wheel base. The footpaths on each side were loaded with 25 tons of pig iron, equal to a human load of 140 lbs. to the square foot, or 50 tons in all. Standing on the bridge was the Corporation steam road roller, weighing 12 tons, attached to a small bogie loaded with pig iron to 18 tons. Alongside it was a traction engine weighing 16 tons attached to a bogie 8½ feet by 6½ feet wheel base, which with the pig iron piled thereon weighed 32 tons. Not only were these weights greater than there was any probability of the bridges being called upon to bear, but the loads were more concentrated than the Lancashire boiler likely to be borne in actual practice. The test, which was witnessed by the Chief Engineer of the Manchester Ship Canal Company and the engineers of several

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important railway companies and corporations, was in every way satisfactory. The first bridge having been loaded as described, a further test with a live load was applied, the two sets of moving loads being driven first over the centre of the bridge, and then on one side, where, on account of the skew, there was the least reinforcement of steel in the concrete, and where, therefore, the resisting power was assumed to be least. During all these operations observations were being made on a platform below the arch by a company of engineers, by means of several steel rods (suspended from plaster of paris moulds attached to the arch) with spring balances underneath. These balances were fitted with indicators to record the deflection, so amplified as to make it visible to the eye. The load of 50 tons on the footpaths remained there throughout the whole of the test. The maximum deflection was about $\frac{1}{25}$th of an inch, although $\frac{3}{8}$ths of an inch was allowed for, and after the removal of the loads the structures resumed their original position. These tests were considered very satisfactory. The second bridge at Mellor Street, and also at a subsequent date, the covering of the River Roch, were similarly tested, with equally satisfactory results. The saving in the initial cost was about 20 per cent. on the estimates for steel construction in both cases.

(*b*) Covering of the River Roch in the Centre of the Town.

Plates Nos. 9 to 12. In this case ferro-concrete appeared to possess such advantages of economy in construction and maintenance—particularly with reference to the avoidance of the requirement of regular painting the underside of a structure exposed to the vapoury emanations from a river largely used for industrial purposes—that it was adopted in place of the ordinary steel decking construction. As the levels of the thoroughfares on each side of the river and the necessary waterway in time of flood, would not permit of sufficient depth of beams relative to the span across the river (about sixty feet, which would require similarly as with steel construction a depth of from 4 to 5 feet), the Author determined to divide the width into three spaces, by providing two rows of columns arranged longitudinally down the river, and in order to cause as little interference as possible to the ordinary flow by the arrangement of such columns the two rows were decided upon, and the river bottom being inverted to the

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centre would allow the normal flow to pass generally centrally between the two rows of columns. The inverting is constructed of ordinary concrete, 12 inches thick, of which the bottom 10 inches is of six to one concrete, the upper 2 inches being formed with a granolithic finish in the proportion of two to one, laid to transverse falls of one in forty-eight. The columns are carried down to the solid shale, which was found at a depth of about four feet below the ordinary river bed, and are constructed of rectangular section 16 inches by 10 inches (with the addition of a cutwater edge upstream), the foundation being extended to a truncated pyramid, 4 feet 4 inches square by 4 inches to 10 inches thick, all reinforced with steel as shown in the cartoon drawings now exhibited.

"Hennebique" column footings consist of a layer of concrete a few inches thick, in which are embedded steel rods in the two main directions, and a monolithic truncated pyramid, connected with the column they support. Such a footing may be considered a girder affected by uniformly distributed loads in an upward direction, and a nearly concentrated load acting downward in the centre. These forces tend to bend the pyramid in the two main directions, and this tendency is effectually resisted by the concrete in compression and by the rods in tension; the bottom rods being supported by "U" shaped hoop-iron stirrups, having the arms bent out slightly at the top. The stirrups (which are employed to resist shearing) are always brought up to just under the surface of the concrete. As the retaining walls abutting on the river were not of too excellent construction to take the additional concentrated load to be put upon them, it was arranged—instead of taking down and rebuilding or strengthening such walls—for the weight to be transmitted more uniformly over the whole length of the wall by the introduction of a ferro-concrete beam, 20 inches deep by 14 inches wide, laid longitudinally on each side on the top of the wall. (See cross section.) It was also deemed advisable in the case of a large elliptical-shaped sewer, which passes diagonally under the river, to arrange for a special treatment of the foundations of the columns which are located upon, or adjacent to, such sewer crossing, by the extension of the principle of the reinforced truncated pyramid previously referred to.

The columns supporting the ordinary flooring are spaced at 13 feet centres in the longitudinal direction of the river, and

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approximately 20 feet centres transversely, but at the upper portion of the work the river narrows somewhat, and thereby reduces the span on the north side only. The covering is divided up into the main beams, which rest upon the columns and the two side walls, these are 16 inches by 14 inches in section, between them are the secondary beams 7 inches by 10 inches in section, which are connected up to the main beam, and in turn receive a flat beam or slab 6 inches thick which constitutes the floor, and upon which has been laid in part the tramway track, consisting of rails 7 inches deep, with hard wood paving blocks, 5 inches deep. The other portion of the floor was laid out as island platforms upon which have been arranged shelters, etc., for the convenience of the tramway travelling public.

(*d*) A further covering of the river Roch for a distance of 45 yards below the Rochdale Bridge, and below the work (*b*) previously described, carried out in 1909. This was on similar lines to the work (*b*), but in the case of the river wall on the northerly side it was taken down and substituted by a ferro-concrete retaining wall constructed of a thin slab with ribs at the back, both the slab and the ribs being connected to a foundation slab with rib at the front at the toe. This work was tested on similar lines to that of the other work, and proved equally satisfactory.

(*c*) Arched Bridge over the Rochdale Canal at Firgrove.

Plate 13. After standing for over 100 years the old bridge was demolished to make way for a wider structure, and the new bridge has been built at a cost of about 3000*l.*; under a joint agreement between the Rochdale Corporation, the Lancashire County Council, and the Milnrow Urban District Council (the canal at this point forms the boundary between Rochdale and Milnrow). Rochdale had the letting of the contract and the supervision of the work, and contributed 1500*l.* (or three-sixths) of the cost, Milnrow paid two-sixths (1000*l.*), and the remaining sixth (500*l.*) was paid by the County Council. The old bridge had a width of only 13 feet between the parapets and there was no footpath. The span of the arch was 21 feet, of which 15 feet was waterway and 6 feet towing path. The new structure measures 14 yards between the parapets, more than three times the width of the one it replaces. There is a flagged footpath 7 feet 6 inches wide on either side, and the roadway, which is

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27 feet wide, is paved with non-slippery granite setts. The span of the bridge across the canal has been widened to 26 feet, made up of 20 feet of waterway and 6 feet of towing path. The widening involved the widening of the towing path on the northerly side. This and other work was carried out before the demolition of the old bridge and the diversion of the road traffic. On the northerly side, almost touching the structure, were two large gas and water mains. By the new scheme these have been carried under the footpath on the northerly side. Under the southerly footpath space has been reserved for electric lighting and tramway cables when these are required.

The Canal Co. required that the headway under the bridge should not be reduced. As a matter of fact, in addition to a wider waterway, the scheme provides a better headway for the whole width of the bridge. There was only 18 inches between the underside at the arch at the keystone and the top of the road above, and it was this that made ferro-concrete necessary. The depth for a stone bridge with increased span could not be provided without raising the levels of the road, to which there were strong objections. Plans had been prepared of girder and other types of bridges, but, on account of the abnormal circumstances, the ferro-concrete method was finally regarded as the most suitable. After certain preliminary work had been executed, the road traffic was temporarily diverted over another bridge, crossing the canal about 150 yards northward, to enable the work of demolition to be proceeded with. The method of demolition, which was carried out whilst the canal was in use, was first to remove the parapets and the backing over the arch. Then the arch stones were removed.

An old, stoutly built, broad-gauge canal boat was placed under the arch to catch the *débris* as it fell, and so prevent it choking the canal. The work, which was risky, was carried through successfully and expeditiously, and without any personal injuries to workmen.

The new bridge is similar in appearance to those in Mellor Street, the chief difference being that the stone parapets are of a plainer type, without perforations. The abutments of the new bridge are supported on both sides by ferro-concrete King piles, 25 feet long by 12 inches square, the length being determined to ensure their being driven down to a satisfactory foundation. Boulder clay was found there by boring at from

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20 to 22 feet below the surface of the water. The intervening strata was not considered satisfactory by the Author. Each abutment is supported by eleven of these piles. The east abutment between the King piles, on the water face, was formed of 12 inches by 6 inches, tongued and grooved, ferro-concrete sheet piles, 12 feet long, which reached 6 feet below the bed of the canal. On the top of the piles there is a ferro-concrete slab, 8 inches thick, supported on the piles by a ferro-concrete beam, 10 inches by 12 inches. This forms the base of the abutment, and the side walls of the bridge, which are of the same substance, 8 inches thick, rise off the top of the slab and beams, and are strengthened at the back by ferro-concrete buttresses, 7 inches wide, in a similar manner to the Mellor Street bridge abutments. The ferro-concrete arch, which has a rise of 3 feet 3 inches, is 8 inches thick at the crown and 13 inches at the springing. Arrangements were made to stop the canal traffic during Whit week of 1906, in order to carry out foundation work. Temporary dams were put across the canal on either side of the bridge. By working night and day this stoppage of the traffic sufficed to carry out all necessary work below the water level in the canal.

The test of the strength of the bridge after completion on September 26, 1906, was on the same lines as those of the Mellor Street bridges, and was witnessed by P. M. Crossthwaite, Esq., M.Inst.C.E., Local Government Board Inspector, who had previously held the preliminary inquiry for the sanction to the necessary expenditure. Over 130 tons weight was on the bridge at one time. The maximum deflection was only about $\frac{1}{12}$ of an inch, and when the loads were removed the deflector instruments practically returned to zero. This was considered highly satisfactory by those who witnessed the test, including several engineers interested in structural engineering work. The Local Government Board shortly afterwards issued their sanction, but limited the period for repayment on the basis of fifteen years for the ferro-concrete work, whereas if it had been carried out in steel, stone, or brickwork they would probably have granted the normal period of thirty years.

Reinforced concrete construction, in the opinion of some engineers, has been under expert observation too short a time in this country to enable any one to dogmatise upon its life; but given a recognised satisfactory system of reinforcement, first-

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class materials throughout, used with first-class labour, under competent supervision, there is no reason to fear satisfactory results under severe tests in the first instance or after the lapse of many years, and the period for repayment might be extended to the same as for other forms of construction without fear of unsatisfactory results.

The whole of the works here described were initiated by, and executed under the supervision of the Author, with whom was associated L. G. Mouchel, Esq., C.E. (France), English agent of the Hennebique Patents. The work was satisfactorily carried out under four separate contracts (obtained at different times) by the Yorkshire Hennebique Contracting Co., Leeds.

Falinge Park.

This park, about twenty-three acres in extent, situated on the northerly side of the town, and presented by Alderman S. Turner, J.P., will always be associated with the coronation of two kings. The first and larger portion, 18½ acres in area, was presented in commemoration of the Coronation of King Edward VII., and opened in 1905, and the addition on the northerly side, 4½ acres in area, in commemoration of the Coronation of King George V., and opened on Coronation Day, June 22, 1911.

The general lay out of the first portion was designed by Mr. T. H. Mawson, of Windermere; the carrying out and supervising of the work, and the design of the gates, boundary walls, railings, building work, etc., was by the Author and his staff. The cost to date to the Corporation for laying out, etc., has been about 15,000*l.*, and in addition the donor has expended for land and certain internal works a somewhat larger amount.

Bridgefold Police Station.

The new Branch Police Station in Mellor Street is a two-storeyed building. The site about 400 sq. yards formed part of the Bridgefold Estate which is Corporation property. The accommodation consists of a dwelling house for the Sergeant-in-charge, a general office, 15 feet 6 inches by 13 feet, two cells 13 feet by 7 feet and an ambulance storage room. The cells are fitted with the electric lights and have separate sanitary accommodation in accordance with Home Office Regulations. The building is of red brick with stone dressings, and is heated

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throughout by hot water, and was designed and supervised by the Author and staff. The total cost of the work including land and paving work in front was 1400*l*.

Electric Tramways.

The Author was the engineer for the promotion in Parliament in 1900 of an authorising Act, and for the subsequent construction of 24¾ miles of tramway track (measured as single track) and the construction of about 3¾ miles by an adjacent authority, leased by them to the Corporation, and the following description of the Track, Car Depôt and Offices relates to the above work.

Track.

The track has been constructed on the 4 feet 8½ inch gauge of 7-inch by 7-inch girder rails, 102½ lbs. weight per yard, with 1⅛-inch by 1⅛-inch groove on straight track, mostly of 60-feet lengths, with fishplates 27 inches long, weight 53 lbs. per pair, supplied mostly by Walter Scott, Ltd., of Leeds Steel Works, and a part by P. & W. Maclellan, Ltd., of Glasgow, from the Angleur Steel Works, Ltd., Liege, Belgium. The rails for curves of 50 feet radius or under were about 105 lbs. per yard, with grooves 1¼ inch by 1¼ inch, and were mostly in 45-feet lengths. The fishplates are secured to the rails by six 1-inch diameter bolts with lock nuts. Each joint is strengthened by a "Cooper & Smith's Anchor" Soleplate, 27 inches long, of similar section to the rails, secured to the bottom flange of the rails by six ¾-inch rivets on each side. The points and crossings were supplied by Hadfield's Steel Foundry Co., Ltd., of Sheffield, the crossings and the tongues of the points being of "Manganese" steel. Some of the special track work at junctions was supplied by the Lorain Steel Co., Ltd., of Philadelphia, Penn., U.S.A., and the remainder by Hadfield's Steel Foundry Co., Ltd. The track is bonded by two "Neptune" bonds at each joint, with cross bonds every 50 yards, the double track being bonded together every 100 yards.

The whole of the track is laid on 5 inches of six to one Portland cement concrete with 1 inch of packing composed of three parts of hard granite chippings to pass through a ½-inch mesh to one part of Portland cement, with deeper recesses at joints

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for concreting round the "Anchor" soleplates, the concrete between rails being finished off with about one and a half inches of four to one concrete. The sides of the rails are plastered with mortar composed of three parts of sand to one part of Portland cement, and the whole paved with granite setts, 6 inches deep, the joints of which are run with asphalte mixture and finished off with cement grouting. Opposite places of worship, etc., the paving is 3-inch by 5-inch creosoted beechwood or Australian hardwood. In some of the later portions of the work cross anchors were introduced under the rails every 30 feet, and in some cases every 20 feet, and the length of the points was increased in the major portion of the work from 8 feet 6 inches to 12 feet and 14 feet. Drain rails and boxes have been freely placed on the track to intercept rainfall above points and also at low-lying places.

Wherever the width of road would permit, and the character of the traffic justify it, the lines were laid double track with "crossover" roads every half-mile; in other parts the lines are single, with passing-places at frequent intervals located so as to enable drivers to see the next passing-place in either direction. The steepest gradient on the system is 1 in 11·7, and the sharpest curve is 35 feet central radius. The construction of the whole of the permanent way works was carried out by workmen employed by the Corporation under the direct supervision of the Author and his staff, the maximum number of workmen attaining to about six hundred. The overhead equipment and cable work was designed by Messrs. Lacey, Sillar, and Clirehugh, of Westminster, and carried out by various contractors under the supervision of the Borough Electrical Engineer.

Car Shed.

Plate No. 14. The car shed stands on the easterly side of Mellor Street, and the whole site covers an area of 11,692 square yards. The land belonged to the Corporation. The shed is a lofty building in which good natural light is obtained from the glazed roof, and is 216 feet long by 100 feet wide. There are two entrances, one at each end, and, as double track is laid along Mellor Street, this allows the cars to be moved in and out of the shed expeditiously and without interfering with the ordinary traffic along that street, which is now the principal tram route to Norden.

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At each entrance from Mellor Street there is a single track, which, after passing through the gateway, forks out in a fan-shaped arrangement into eight sets of lines into the main shed, and two tracks into the repair and painting sheds, which lie on the easterly side. So that in case one entrance happens to be fouled by a car off the line, the other will still be open for the admission or discharge of the cars. Underneath the lines on which the cars rest there are continuous pits running from end to end, and from side to side, the tracks being supported on steel stanchions, between which are steel joists carrying the rails to which they are bolted. These steel stanchions are firmly fixed below the level of the pit and surrounded by solid blocks of concrete. The pit arrangement is adopted so that when workmen are engaged on repairs to cars they can pass underneath from one car to another in any part of the shed. All the spaces adjoining and between the tracks are laid with pitch-pine planks, with the exception of the two adjoining the main walls, which are of concrete, with intervening spaces between the planks, so that when the cars are being washed the water will go through to the pits which are well drained. The planks are arranged in bays so that in case a car is in a bad condition and cannot conveniently be taken to the repair shop, they can be removed to allow an apparatus to be put down in the pit to raise the car which is in need of attention.

The repairing shop, which is 117 feet long, and the paint shop, 45 feet long, are on the river side of the erection. Off the repairing-shop are the general stores, mechanics', blacksmiths', and joiners' shops, the men's messroom, the foreman's room, and workmen's lavatories; and off the paint shop there is the armature repairing shop, while below and above are still further rooms which are utilised for storage purposes. Below the level of the car-shed pit there is an open subway, which communicates with the lower floor storage rooms and also with the repair shop, so that motors can be taken from underneath the cars and carried along it on trolleys to a point near to the mechanics' shop. The whole of the buildings are of brick relieved by the introduction of terra cotta in the salient features of the design. The shed was designed to accommodate fifty-six cars of the type then in general use, but owing to the subsequent introduction of large bogey cars the accommodation is reduced to about forty-nine cars. There is room on the site, or on the opposite side of the

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street, for an extension. The shed was brought into use on 15th July, 1904.

Offices.

The building is in the renaissance style and of red brick, the front being relieved by the introduction of terra cotta and white stone in the salient features of the design. It has an imposing frontage to Mellor Street which is apt to give a somewhat false impression of its dimensions. Though occupying a long frontage it has no great depth, all the rooms overlooking the street. Behind them is a corridor, five feet wide, from which every apartment may be entered, and which also has easy communication with the shed, and in turn, with the workshops. Passing into the hall through the entrance in the centre of the block on the right is an inquiry office, and adjoining it a small room in which business and other callers can interview members of the staff. Immediately beyond is the general office, 39 feet by 18 feet, well lighted and with ample accommodation for a large staff of clerks. Next to the general office is a room, 18 feet by 15 feet 6 inches, used as an office for the inspectors. It is fitted with steel safes for conductors' ticket boxes, etc. Beyond is the office at which the conductors pay in their cash. This is 22 feet by 18 feet, and is fitted with a long counter, screened from the corridor by six lifting sashes, and may be shut off entirely from the corridor at will. Adjoining the cash office are lavatories for the use of the motormen, etc.

Returning to the hall and traversing the corridor to the left from that point the first room is the draughtsmen's and cost clerk's office, a room 19 feet by 18 feet. Adjoining this is the traffic superintendent's room, and next the general manager's office, with a bay window. Opening out from the general manager's office is a room, 22 feet by 15 feet, which is utilised as a stationery store and for the correspondence clerks. At the end are lavatories for the office staff. The main portion of the building in the centre has been carried two storeys high. On the second floor is a room originally intended for a committee room, 39 feet by 24 feet, and 15 feet in height, but now used for storage and issue of tickets. To the left of the landing are two rooms, one of which is used as a store fitted with partitions, and the other as a general storeroom for spare uniforms, lost luggage, etc., and at the end lavatory accommodation is provided.

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There are three cellars for heating, storage, and other purposes, and here again communication is provided with the car shed behind. The heating of the offices is on the low-pressure hot-water system. The premises are lighted by electricity, and there is telephonic communication between every department as well as between any room in the offices and the car shed and workshop. A dwarf wall, 2 feet 6 inches high, surmounted by wrought-iron railings also 2 feet 6 inches high, runs along the front of the building. The offices were brought into use on 23rd June, 1905. The offices and shed, combined with the workshops, etc., complete what is considered a well-arranged and equipped depôt. The builder's work, furnishing, laying of tracks, etc., were carried out from the designs and under the direction of the Author; the electrical equipment and lighting under the Borough Electrical Engineer; and the arrangement and fitting up of the workshops under the General Manager.

The total cost of the depôt and offices, including all equipment, etc., was about 32,000*l.*

DISCUSSION.

Mr. J. S. Brodie: It gives me very great pleasure to propose a vote of thanks to Mr. Platt for the very interesting paper which he has given us. The first part of the paper will be very interesting to those engineers who are engaged in solving the problem of sewage disposal in inland towns. I am, of course, no authority upon this subject. I should, however, like to ask Mr. Platt what he does with his sludge. Further, as a matter of information, I should like to ask what period the Local Government Board allow for repayment of loan for this kind of work. I have read from time to time what has taken place in Rochdale upon this subject. The Rochdale works are referred to again and again in the reports of the Sewage Commission, which seems to show they are a model in this class of work. Coming to the reinforced concrete I am a little more at home, and the works described by Mr. Platt are certainly very interesting examples of reinforced concrete construction. I had the pleasure of knowing the late M. Mouchel in connection with ferro-concrete work, and a more able and honest engineer I never met. If the proposed erections were not suitable for ferro-concrete, or there was no advantage in its use,

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M. Mouchel always had the manliness to tell you so. That is a great point in a contractor, if he will tell you when he does not see any practical or economical advantage in adopting ferro-concrete construction in the work he is proposing to tender for. It is interesting to note the good results of concrete made from "Lonkey" rock. I do not know a rock of this name, but Mr. Platt is a geologist, and knows these technical terms better than I do. I have also made concrete from a broken rock which I think is the same stone, and I can bear testimony to the high efficiency of the concrete made. With reference to the ferro-concrete bridges, Mr. Platt estimates the saving over steel construction at 20 per cent. I think he is to be congratulated on this saving. Mr. Platt alludes to the short terms of repayment, which the Local Government Board grant for this class of work, namely fifteen years instead of the usual thirty years. A good many engineers have written to me as to their experience in this matter, and I have always told them, "If you do not like the Local Government Board do not go to them; proceed in works of any magnitude by private Act." One cannot really blame the Local Government Board for a policy of safety, especially with work upon which they have had no time to mature their judgment. I have no doubt in time that the full period of thirty years will be allowed for works of ferro-concrete. The only thing which will upset that will be, if some one works with a poor cement, and moisture gets in and sets up erosion of the bars. As in all these works, while thirty years may be allowed for really sound and proper work, inferior work would be highly rated at ten years. The question of workmanship and materials should be taken into account. I suppose the Local Government Board, with the more modern and scientific conditions under which work is now carried out, will send an inspector round to see how the money has been spent, and it may be in the wisdom of the Board, the period for which the loan is granted will be extended if the work is properly carried out. If the work is not first class one cannot be surprised if the work does not last very long. I should like to add a word of congratulation to Mr. Platt. I notice in the minutes of the Institution that we had a meeting at Rochdale in 1883, and another in 1897, and now we have this third meeting to-day. I believe Mr. Platt has attended all these meetings and I congratulate him thereon, and hope that he will be to the fore

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after another sixteen years' interval, to welcome us again to the good old town of Rochdale.

Mr. William Stubbs: I am pleased to second the vote of thanks to Mr. Platt for his most valuable paper. I have carefully read the paper and have seen most of the ferro-concrete work carried out. I regard Mr. Platt as the pioneer in the district for this class of work. When my Committee was considering the construction of bridges, I brought them over to see the one, then in course of erection, in Rochdale, and since that time, we have in Blackburn, constructed four bridges in ferro-concrete, besides arching over a considerable length of a river in the town, and the construction of a covered reservoir to hold 3 million gallons of water. With reference to the Sewage Works, I would like to ask Mr. Platt what he does with the solids from the humus tank. There is not much difficulty in pressing the sludge from the septic tank and the ordinary sludge, but the sludge from the humus tank I find impossible to press. My Corporation have not used their sludge presses for the past eighteen months, the sludge having been squeegeed into the land. It was costing from 3*s*. 9*d*. to 4*s*. per ton for the pressing of sludge, which was rather an expensive matter. In my opinion, Mr. Platt's paper is as practical as any that has been before the Institution.

Mr. H. Gilbert Whyatt: In his paper Mr. Platt has mentioned that he gave a description of the Town Hall in a previous paper in 1897. The very first building that I was taken over during my pupilage was the Rochdale Town Hall, and I have notes of some of the things I saw then and which struck me as being most interesting. I have two or three questions to ask. I am not quite sure with regard to the statement in the paper as to the sediment in the humus tank—what it consists of. Personally I have not got the sewage problem. I was formerly in touch with it, but now I am a bit out of touch, and it seems to me there is a good deal of treatment if the sewage first goes through settling tanks, then through percolating filters, and then requires to be sedimented again in humus tanks. I should like to ask what that sediment consists of. Is it disintegrated coke, or is it some oxidisable matter which forms in the sewage in the filter? Mr. Stubbs raises the question as to how they manage to press this humus sludge. I can quite see the necessity of taking it

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through the settling tanks again, because then it mixes with the ordinary sludge. With regard to the Lonkey rock to which Mr. Brodie referred, we used Lonkey setts in Salford twenty years ago, and I understood it was the local quarryman's term for that stratum. I do not think there is any other origin for the term. It does not describe the stone in any way; but I take it it is a quarryman's term. It is a good hard stone fit for second-class streets. A point struck me as to the pile foundation for the Mellor Street bridges. Mr. Platt has carried the foundation down through the coal workings to the solid. As subsidences still go on will the bridges eventually stand up some feet above the adjoining streets? I have a similar problem. I am carrying a sewer through an old river bed, and in the excavation we found five different lots of road metal a matter of 5 feet thick over the peat, which is 25 feet thick. The piles will hold the sewer up, while the surrounding ground goes down. I should like to ask whether Mr. Platt anticipates a similar effect, and whether the bridges will stand up above the surrounding ground as the ground subsides.

Mr. E. Worrall: I wish to add my thanks to Mr. Platt for the valuable information he has imparted to us. What struck me principally in connection with the ferro-concrete structures was the central fact of how little difference there is in principle between the many systems. Whenever we propose to embark upon this method of construction we are besieged by some dozen agents of different systems, each one of whom claims theirs is pre-eminent. The real engineering difference, however, is small. One firm distorts its reinforcement in one way and gives it a name, another firm twists its reinforcement in a different direction, gives it another name, and claims for that twist some particular advantage, I discount those claims by reference to the fact that the adhesion between ordinary concrete and steel bars cannot be exceeded in practice. Hence, to increase that adhesion is superfluous. Another thing which struck me in connection with the Mellor steel bridge is the rubble backing, which has been provided for the bridge at its abutments and the arch. One understands the use of rubble backing on a bridge constructed with brickwork; but in ferro-concrete I do not quite see the reason for the extra cost incurred in backing up the whole structure with rubble. Reference has been made by one or two speakers to "Lonkey," as applied to

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the lower strata of Haslingden stone. I have heard it variously described, one foreman has told me it was an abbreviated corruption of "Lancashire." That was not a very scientific derivation, but it was his view. In that connection one describes Lonkey stone for Lancashire sett paving. I think Mr. Platt is very modest indeed in his estimate of the saving he attributes to reinforced concrete for the structure in front of the Town Hall. If the saving for maintenance compared with girder work in the course of years could be capitalised, it would I believe represent nearer 40 per cent. or 50 per cent. than the modest 20 per cent. he estimates.

MR. W. WELLBURN: I have very great pleasure in supporting the vote of thanks that has been so well proposed, because I know very well the large amount of work that has been carried out by Mr. Platt. I very often come to Rochdale, and know what is going on. There is one question I should like to ask Mr. Platt as to the sewage disposal—the cost per million gallons. I admit that the question is rather premature, because the works are not yet in full working order. The other question is—how they dispose of their sludge and what quantity they have to dispose of.

MR. PLATT: That is mentioned in the paper.

MR. WELLBURN: The dealing with the sludge is rather a difficult matter. Farmers cart it a long distance. I had an application from a Yorkshire firm who were prepared to buy our sludge if we would cart it and put it on the railway trucks. I find it will cost us more to cart the sludge two or three miles to the station and put it on the trucks than to press our sludge.

MR. C. BROWNRIDGE: I should like to bear testimony to the excellence of Mr. Platt's work and the excellence of the paper he has put before us. As engineers, it is our duty to profit by mistakes. Fortunately, Mr. Platt has no examples here of mistakes made in ferro-concrete. The paragraph in the paper dealing with the necessity of the work being entrusted only to persons properly qualified is a very important one. In Birkenhead we had a reinforced concrete floor supported by reinforced concrete pillars. This floor was constructed to carry a stable building. It was constructed by specialists under professional supervision. I may say in passing that professional supervision was not mine. I took exception to some of their proposals. They considered that their proposals were ample and

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satisfactory for the purpose required, and before any action by the local authority could be taken the floor collapsed and seriously injured several men. I think it is necessary, therefore, to bring before a meeting like this little cases of failures as well as examples of successes, in order that we may be on our guard. It is, no doubt, cases like this which influence the Local Government Board in limiting the period for which they are granting loans. On the question of the length of loan for ferro-concrete work, I do think, when the period for which the loan is granted has half expired, if later experience proves it is not for a sufficiently long period, then the period might possibly be lengthened; but I do agree with the policy of the Local Government Board in at present limiting the period of loans for ferro-concrete work. With regard to Mr. Platt's most excellent experiments with various kinds of sand, I was very interested in seeing that the Lonkey stone crushes rather coarse. In looking at the setts, the grains do not appear very large or coarse, but I can bear testimony to the excellence of Lonkey stone. I have a considerable quantity of it laid in Birkenhead, and there is no doubt it is of very great wearing capacity, and I am pleased to see it is going to be of value in reinforced concrete work. There is one portion of the paper which has not been referred to by previous speakers, and that is the very important question of tramways. I would like to know what is the general nature of the subsoil upon which the tracks are laid—whether it is chiefly of a sandy or rocky nature. I am pleased to note that Mr. Platt is increasing the cross anchoring of the rails at shorter distances. That I think bears out the general experience of most of us. The question of subsoil in tramway work is a very important one. I find, where we have the tramway track laid upon a dead bed, the track will stand practically without repair, but where the track is laid upon clay, or a clayey subsoil, the repairs are very considerable. I would also like to ask Mr. Platt—I see he has put down drain rails and boxes—whether he has put down any water-taps or outlets in the grooves to water the grooves in dry weather. We have experimented in that direction, and the work has been very successful.

Mr. E. Witton Booth: I have one question to ask with regard to the manufacturer's refuse. You say it is largely from wool scouring. Is it of a similar character to the refuse in

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Bradford? I believe the Bradford Corporation, at their sewage works, make a good deal of money out of their sludge. It struck me as to whether the wool scouring in Rochdale is similar to that in Bradford, and whether there is a money value in your sludge in the same way as the Bradford people so successfully make it.

MR. H. GARWOOD: Some curiosity has been expressed as to the derivation of Lonkey. There were Lonkey sheep before there were Lonkey setts. The Lonkey sheep were noted for a blue tint in their wool, and the Lonkey setts are noted for their blue tint.

MR. W. A. PIERCY: Will Mr. Platt give the name of the quarry from which the non-slippery setts are obtained?

THE PRESIDENT: Before asking Mr. Platt to reply, I should like to put the vote of thanks to him for his most admirable paper. With reference to the sewage disposal works, it seems to me that the Corporation have been moving forward gradually and have had so far excellent results with a very foul sewage. I believe that what we shall see at the sewage disposal works will satisfy us that Rochdale is on the right track. Reinforced concrete is a matter which concerns us all very deeply nowadays, and I agree with Mr. Brownridge that we, as engineers, should not conceal the fact that failures occur. Details of these may be of even greater advantage than those of works which have been successfully carried out. I was recently at a meeting of the Concrete Institute, and heard from the President that the Local Government Board had written a letter stating the periods for the repayment of loans on reinforced concrete work, and, although it was a characteristic letter written in general terms, not committing themselves very much, it did state that, for bridges in the form of beams, ten years would be allowed, and where the bridge was in arch shape, fifteen years. I am inclined to agree that the Local Government Board are well advised in not extending the period of loan, although the suggestion of Mr. Brownridge is a very practical one, that when the period of loan is partly expired, and the work is obviously sound, they might extend the period. We have been carrying out ferro-concrete work for some years, and the whole secret of success depends upon the supervision—supervision, not only by the foreman in charge, but by the engineer. So far as I am concerned, I always have an assistant permanently on the job,

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because, however well the foreman may supervise, even he cannot knock out of workmen that ingrained instinct or desire to scamp things. Workmen have got so imbued with the idea of rushing over their work quickly and getting away, and you do not often get the old type of man who likes his work, and is ambitious to make a good job. I do agree that it is most essential to get our Councils to see the necessity and the economy of efficient supervision of ferro-concrete work. I have to thank Mr. Platt for his examples of tests of strains of ferro-concrete work. To me they will be most useful. As to the tramways, I see no reference to corrugation. It seems to be a horrible nightmare in the South of England, how they are caused and how they are to be prevented. If Mr. Platt has no corrugations to complain of, we must congratulate him. If he has, I would like to know what he suggests is the reason for corrugation, and what remedy he suggests. We had a meeting some months ago on this vexed question, and it was surprising to find the difference of opinion on corrugation. Some said it was due to one thing and some to another. There were two schools—one said corrugations were due to too firm and solid a foundation and others to having a resilient foundation. Perhaps Mr. Platt could enlighten us on the subject.

The vote of thanks was carried unanimously.

Mr. S. S. Platt, in reply: In the first place I am much obliged for the unanimous vote of thanks, and I can assure you it has been a pleasure to prepare this paper, and in putting the information before you I have tried to give you something that may be of use when you get away from the meeting. I do not know whether I have any failures to show you. You will see, if you read between the lines, that there were things at the sewage works where they did not follow my advice, but they had to come to it later. Mr. Brodie asked about the disposal of the sludge. We press the sludge in six presses, down to about fifty per cent. of moisture. One-third to one-half of the annual output is taken by local farmers, and we give them 6*d.* per load to fetch it away, the remainder is sent to Ormskirk district, and they pay the railway carriage. We do not mind so long as it does not cost more than about 6*d.* a ton to get rid of. It is intended to go in for a plant to supplement the pressing by further drying and getting it into such a condition that it is anticipated a remunerative price will be obtained for it. It

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appears there is a large demand for cheap manure in Canada and South America, and there are firms picking it up. That is what they do at Bradford; beside recovering the grease it is further dried and packed to go abroad. With regard to the period for repayment of loans for sewage works, we have thirty years for the general construction, and fifteen for the electrical pumping plant, etc. With reference to the ferro-concrete bridges, when I showed M. Mouchel the Lonkey stone he considered it an excellent stone for the purpose. The percentage of saving was about twenty per cent. over steel work in this particular job; but apart from cost, steel and masonry were out of the question in the case of the Firgrove Bridge without raising the road, which is already of a steep gradient. The Mellor Street bridges were constructed under an Act of Parliament. The Firgrove Bridge was built under an application to the Local Government Board, which gave us an informal sanction. They said, "Go on with the work; we will inspect it when completed, and see the result of the test." The test was perfectly satisfactory, and the Board granted us a loan for fifteen years. As to moisture in the ferro-concrete, in one of the jobs (the river covering) there was a little moisture came through at one or two places, and I was a little concerned about it at the time, but it racked up. It was where the men had left off their work and started again. Now I insist in such cases upon the work being picked away before any further concrete is added. At the same time where you have a thickness of only 6 inches of concrete, it is a question whether it is not well to put asphalt over it, because everything depends upon the wet being kept from the steel. I have therefore, in the last two jobs, put a thin layer of asphalt sheeting over the work. Mr. Stubbs mentioned the solids from the humus tank. It is really flocculent organic matter in a very fine state of division. The peculiarity about the percolating filters is that if you put 50 grains of solids on, 50 grains will come out, but it will be so broken up that it is not so easily seen, whereas if you do not periodically take it out of the humus tank, it will slough up in hot weather, the fine humus going over the sill at the end, and deteriorating the affluent. Although I have an ejector in which I could put it, I pump it into the branch outfall main along with the sewage, and make the sewage carry it to the main works, and there precipitate it with the other solids in the tanks. The humus is of such a slimy

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character that it cannot be pressed by itself. We have always had to mix the humus sludge from the small experimental filters with two or three times the quantity of ordinary tank sludge in order to press it at all. Mr. Whyatt referred to the Town Hall, and I was very pleased to hear his remarks. It is really a magnificent building. It is under my charge, and I take very great pride it. Although there are faults about the accommodation, they are not altogether the fault of the architect, but due to the expansion of the municipal requirements. The general decoration of the whole building, including the modern stained glass, is very fine. Mr. Whyatt asked about the possibility of subsidences. I do not fear any subsidences in connection with the ferro-concrete bridge. The new street (Mellor Street) is not settling down to any appreciable extent. It is not like peat. But to put bridges on a strata which is undermined would have been to court disaster. Mr. Worrall referred to the variety of reinforced concrete systems. In the competition for business I fear some are running things too fine for safety. The rubble backing was used instead of filling in with dirt, in order to get as solid a backing as we could. Mr. Worrall is correct in saying there will be a saving in maintenance as well as in the original cost of the river covering. With some ironwork which was done there years ago, I was horrified to find the amount of corrosion which had taken place. I am sorry I cannot at the moment give Mr. Wellburn the cost of sewage treatment per million gallons. The cost of pressing is about 3*s.* 6*d.* per ton. That does not allow anything for interest or sinking-fund charges. Mr. Brownridge has referred to the cautiousness of the Local Government Board. I am not surprised at it, considering the variety of systems on the market. He also referred to the tramways. There is clay, and most kinds of subsoils; we have not had any special trouble. The concrete of the tramways has stood very well. My experience with ferro-concrete had also made me careful as to having good concrete. The work was all done by administration, and I got a good set of men together. With regard to corrugation, I am sorry I cannot throw any light upon it, and I cannot tell you what is the cause of it. There seems to be such opposite views about it. With two different qualities of rail the corrugation seems to be going on, with both straight and curved sections of rail, generally speaking. I am proud to say our track has stood very well, and will compare

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favourably with any in maintenance. The trade refuse in the sewage is principally wool scouring, but not to such extent as at Bradford. For a considerable time our manager scraped off the scum and sold the fat. As a result of frequent inspection of the trade effluents entering the sewers, the quality of the sewage has gone down somewhat during the last two or three years. Mr. Piercy asked as to the non-slippery setts. They are "Gimlet Rock" from Pwlhelli. I do not know a sett better suited for steep gradients. The President referred to the secret of success in ferro-concrete work. He hit the nail on the head when he said it consisted of capable supervision. I had two jobs going on at once, with an assistant on each, and the job was never left. I am pleased to say the contractor had men who were experienced in this class of work, and the results proved very satisfactory.

The Members had luncheon together at the Town Hall, Mr. R. J. Thomas presiding. In the afternoon visits of inspection were made to Falinge Park, the branch police station, tramway depôt and offices, ferro-concrete bridges, sewage disposal works, and other municipal undertakings. Afternoon tea was served at Roch Mill House.

When visiting the tramway depôt, by the kindness of the General Manager, J. S. D. Moffet, Esq., A.M.Inst.C.E., the Members had an opportunity of seeing practical examples of the use of the oxygen-acetylene plant used for cutting and welding parts of tramway rolling stock, and for making good hammered joints on the permanent way.

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WEST MIDLAND DISTRICT. MEETING AT LEEK.

July 5, 1913.

Held in the Town Hall, Leek.

R. J. THOMAS, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Members were received by Mr. Thomas Mason, J.P., the chairman of the Urban District Council, who offered them a hearty welcome to the town.

The President thanked the chairman for his kind welcome.

A vote of condolence with Mrs. Carter Bell on the death of her husband, was passed unanimously.

The following paper was discussed.

LEEK AND ITS MUNICIPAL WORKS.

BY W. E. BEACHAM (*Member*),
TOWN SURVEYOR AND WATER ENGINEER.

WHEN the Author received the intimation from the secretary of the West Midland District that the Executive Committee thought that a meeting should be held at Leek, it was regarded more in the light of a compliment that was desired to be paid to the town and its representatives, than to himself as its engineer and surveyor, and though the view was expressed that after the completion of ten years of service the Author could not point to works of any great magnitude, it must not be assumed that real

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municipal progress had not been made; but, seeing that the Institution had never met at Leek, and considering the importance of the town, the Author was prevailed upon to trouble you with this paper, in the hope of proving that there are works of interest to the members of the Institution even in the smaller towns. The Author is sure that his Council appreciate the compliment paid, and hope, with him, that the visit may prove of interest to the members.

HISTORICAL.

Leek is known throughout the county of Staffordshire as "The capital of the Moorlands," and has figured largely in the pages of history. In earliest records (according to Sleigh's "History of Leek") Leek or *Leke* is variously written *de Leica vel Lecha*. As to the origin of the name of the town, authorities incline to the opinion that it is derived from the Cymric *lech*, a stone, which the nature of the country in its immediate neighbourhood seems to corroborate, rather than from *leak*, which is equivalent in its meaning to water, and from which are evidently derived *Leck*, a river in the Netherlands, *Lech*, another river in South Germany, and *Leuk* in Switzerland, noted for its hot springs, or from the old Norse *lûk*, Anglo-Saxon *lic*, a corpse. Leek in the old Celtic meant a desert place, and this derivation is favoured by the vast tracts of wild moorland, with their infinite distances of brown waste, rolling mists, and snow-capped Roches. In Doomsday Book it is thus referred to: "The King holds Lec, and Earl Algar (son of the celebrated Godiva of Leofric, Saxon duke of Mercia) has held it. There is one hyde (which some suppose to be 120 English acres, and others again very much more), with its appendages." In the time of Edward the Confessor it was valued at 4*l*.

In August, 1723, the Manors of Leek, Leekfrith, and Rudyard were sold to the Lord Chancellor Macclesfield for 10,354*l*. 7*s*. 8*d*. The great Lord Chancellor was born, so Lord Campbell writes in his "Lives of the Lord Chancellors," on July 23, 1666, in an old stone house, still remaining at the top of the market-place. The present lord of the manor is the seventh Earl of Macclesfield. The ancient parish church, dedicated to St. Edward the Confessor, boasts of a noble Norman tower, and of two Catherine-wheel windows, one of which is engraved in Bloxam's "Gothic Architecture."

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Geology of the District.

Our oldest rocks (according to the late Sir Thomas Wardle's "Geology of Leek") are those of the lower carboniferous system, underlying the coal measures horizon, yielding Yoredale sandstone and shales and millstone grits, all more or less capped with brick boulder clay of the glacial period, containing water-worn pebbles and boulders of older rocks. The soils resting on these clays are more or less clayey, and are unlike the soils which lie upon the Triassic or new red sandstone beds which occupy and rest unconformably in a palæozoic trough in the Churnet valley at Leek. Between these two great formations in this locality, *i.e.* the lower carboniferous and the Triassic, a vast thickness of rock has been removed by denudation, including the whole of the millstone grit formation of about two thousand feet thick, except portions which have been left as at the Roches (the source of the town's water supply) in the north, Ladderidge in the south, Rudyard in the west, and Wetley Rocks in the east.

The prevailing colour of the sandstone of the Leek district is deep red, though the colour varies, and in some parts is found nearly white. The redness is due to the presence of peroxide of iron. Under the microscope it appears to be very small and partially rounded pebbles, nearly uniform in size; they are grains of crystalline white quartz. The sandstone is considered to have covered this district more generally than it does now. Its subsequent partial removal by denudation is supposed to have left the surface in those graceful undulations of hill and dale which give so great a charm to the scenery of the neighbourhood. The beautifully rounded hills of this formation on the south and west sides of the town are strikingly characteristic of the period to which they belong, and enable the spectator readily to distinguish between them and the more abrupt elevations of the surrounding millstone grit. The eastern side of the town stands on the millstone grit, the line of junction with the new red sandstone being in Market Street, a few yards from our place of meeting, and runs due south. From this formation various qualities of stone are obtained. From the Waste and Kniveden quarries stone used for wall building, road mending, and other like purposes are obtained, while from the Morredge quarries Roche stone is obtained, and may be seen in most of our public buildings, being used for quoins, window heads, sills, and all

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kinds of dressings. The highest elevation of grit in the district are the Roches, 1670 feet above sea level. The centre of the town is 643 feet above ordnance datum, varying from 748 feet at the eastern boundary to 484 feet at the west.

STATISTICAL.

The town of Leek, with the townships of Leek, Lowe, Leekfrith, and Tittesworth, as defined by the Leek Improvement Act, 1855, comprises a circle 3000 yards in diameter, the centre being the lamp pillar in the middle of the Market Place. The area is 1460 acres. The population estimated at the passing of the Leek Improvement Act in 1855 was 9500, at the last census it was 16,654, to-day it is estimated at 17,000. The number of inhabited houses in the town is 3796, giving an average number of persons per house of 4·39. The health of the district is good, as the death rate for the year ending December, 1912, was only 16·6 per 1000. The total rates are 6*s.* 8*d.* in the £, and include County Council and education rate of 3*s.* 8*d.*, and general district rate (including 4*d.* in the £ for water) of 3*s.* The rateable value of the town is 62,334*l.*

INDUSTRIES.

With regard to its staple trade an old Staffordshire ballad has said—

> "For silken fabrics rich and rare,
> What city can with Leek compare?"

and to-day Leek is (thanks to the enterprise of its manufacturers) a thriving hive of industry, and is noted the world over for the quality of its productions. The silk trade of Leek seems to have originated with some French refugees after the Revocation of the Edict of Nantes in 1685, and although the nature of the industry has changed somewhat since then, in that the making of broad silks is not now very general, a very considerable trade is carried on in the making of the finer lines of silk goods, such as sewing silks, bindings, braids, ties, etc., and, from the number of new silk mills and extensions to existing ones which have just been carried out, there is every prospect that the trade of the town will still largely increase. Silk dyeing is also carried on to a large extent, and forms one of the principal branches of the industry, the local water being especially suitable for the purpose.

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Roads and Streets.

Prior to the year 1825 the streets and highways were managed by highway officers appointed at Vestry Meetings, but on May 20 of that year an Act for lighting, watching, cleansing, and improving the town was assented to by King George IV., which contained the following interesting recital: "Whereas the town of Leek in the county of Staffordshire is large and populous, and a place of extensive trade and manufacture, and greatly increasing, and is also a great thoroughfare for travellers, and where many fairs are held, etc." Such Act was administered by Commissioners until 1855 when the Leek Improvement Act was passed, which gave extended powers to the Commissioners. It also increased the area of the town from 1200 to 1500 yards from the centre of the market-place. Such Commissioners as were from time to time appointed under the Act remained in office until the Local Government Act of 1894 was passed when Urban District Councillors were appointed. The total number of streets in Leek, excluding private streets, is one hundred and fifteen, with a mileage of 13¼. In addition to which there are 3½ miles of main roads which the Urban Council under Sect. 2 of the Local Government Act of 1888 decided to retain the powers and duties of maintenance over.

They are paved approximately as follows:—

Lancashire setts	2⅜ miles.
Granite „	328½ yards.
Tar macadam	1¼ miles.
Stone macadam	9¼ „

The principal streets in the town are paved with Leicester granite, and 5-inch Lancashire grit setts, on concrete foundation, which tend to give them a cleanly appearance, and is suitable for the heavy traffic to and from the mills, while up to the Author's appointment the secondary streets were made of local stone macadam. This stone, though cheap, was comparatively soft, and did not wear well, and upon the Author's advice a second quality Leicester granite was substituted, which wears much better, gives off less dirt, and is generally appreciated, because it is being recognised that cheapness is not necessarily real economy, and that though first cost of a harder and better stone is about 50 per cent. more than local stone the longer life, and saving in scavenging, will repay the greater initial outlay, and it is hoped that local

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stone will eventually be altogether superseded. The cost of local stone delivered on the streets was 6*s.* per ton, whereas second quality Leicester granite is 8*s.* 3*d.* at the station.

The use of tar macadam is increasing in the town, though up to 1903 the only length of carriageway laid was that in front of the Town Hall, but the Author in the restoning of certain flat streets, advised the stripping of the old local stone macadam down to the pitching and the laying of tar macadam in two coats, 5 inches deep, bottom of 1¼ inch to 1 inch gauge and 3 inches deep, and top ¾ inch to ⅜ inch gauge and 2 inches deep after rolling. The stone was limestone obtained from the Froghall quarries, treated at the works, and cost at the canal wharf, 11*s.* and 12*s.* 4*d.* per ton respectively. Each coat is rolled with a ten-ton roller, and the street is opened for traffic in a few days after rolling. The Author's experience is, that a ten-ton roller is too heavy for tar macadam, and he prefers a six or eight ton roller, but as the Council do not possess their own roller, and are compelled to hire, it is not always possible to make the best job, because the streets have to be rolled to a finish in order to liberate the roller, and oftentimes it is impossible to obtain a roller when the weather is favourable, on account of their being so far away and engaged on their own work.

By reason of the gradients of the streets in the town, some doubt originally existed as to the desirability of using tar macadam to any great extent, as the bulk of the heavy traffic into the town is from the station, and as the main approach has a gradient of 1 in 19·23, and the horses are shod with heel and toe, in order to overcome the gradient, it was feared that when the traffic got on to the tar macadam streets great damage would be done, and disintegration of the surface would commence, but it is found that the streets that have been so laid stand very well. One length of street, quite flat, over which there is considerable heavy traffic in connection with a corn stores and coal depôt, was laid with Welsh granite treated at our own yard with tar, but at the end of about five years was very badly damaged and clearly showed that tar macadam is not altogether suitable when subject to heavy traffic, even on a flat gradient. The reason granite was tried on this street was because it was known it would be subject to heavy traffic, and being harder than limestone and possessing better wearing qualities, it was thought the experiment should be tried. The Author thinks this is a street that

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should be sett paved in future, but is satisfied that tar macadam is very suitable for secondary streets with flat or slight gradients and subjected to light traffic only, and is extending in this direction as streets become ready for stoning; 1¼ miles of this material has been laid as carriageways, and the cost works out about 2*s.* 6*d.* per square yard. Recently a portion of one of the main streets of the town which had been laid with Macclesfield setts was repaved with 4-inch to 5-inch Lancashire grit setts which worked out at 7*s.* 6*d.* per square yard, excluding concrete foundation. The main roads of the town (known as the county roads), with the exception of the station approach to the town which is part paved with Leicester and Lancashire setts, are all of granite macadam from the Clee Hill Quarries. The stone cost 12*s.* 10*d.* per ton at the station.

Footpaths.

The footpaths in the town generally are laid with Macclesfield flags with kerbs from the same place, but the Author soon after commencing duties at Leek, had to lay the whole of the stoneware conduits in connection with the installation to the electricity undertaking into the town, and found it exceedingly difficult to take up and relay both flags and kerbs on account of their tendency to laminate. It is the practice now to use Lancashire kerbs and flags which can be easily taken up and relaid. The street channels and crossings were also laid with cubes, but the Author favours the use of 12-inch by 4½-inch flat channels laid on concrete bed which makes the better job, and the crossings are laid with a similar material, grooved to afford a foothold for horses. In the private streets of a secondary character, 2½-inch artificial flags are being laid. A Leicester flag made by Messrs. J. Ellis and Sons has been standardised, and all the footpaths laid out in connection with new streets by estate agents, have these flags specified. The cost of artificial flags at Leek is 3*s.* 10*d.* per square yard, and Lancashire sawn flags, 5*s.* Lancashire kerb, 10 inches by 8 inches, cost 3*s.* 6*d.*, and 12 inches by 6 inches, 3*s.* per lineal yard, while Macclesfield cubes, formerly used in the channels, cost 3*s.* 6*d.* per square yard, as against 2*s.* 5*d.* for 12-inch by 4½-inch flat Lancashire channelling per lineal yard. The footpaths to the main roads nearest to the centre of the town are flagged or tar paved, while the lengths beyond to the boundary, are gravelled or ashed, but

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an arrangement has been come to whereby we hope to extend the tar paving in lieu of ashing, which will be much appreciated by the users. Our cost of maintaining the main roads is submitted to the county surveyor before payment, and we consider we are treated with every consideration, and in the matter of widening or improvements an arrangement is generally come to before the work is done between the Urban and County Councils, whereby the cost is met jointly.

Private Streets.

These formerly were laid out by the estate owner and completed with footpaths before any buildings were erected, and immediately upon their completion the builders commenced building operations, and considerable damage was done by means of drain connections, gas and water services, etc., and the estate owner was called upon to again put the streets in order previous to their being taken over. The Author favours the idea of simply laying out the street with sewers, kerbs, and pitching put in only, and when buildings are completed the street to be made up and adopted by the Council. The specification for the formation of the road usually adopted is 8 inches to 12 inches of hardcore, with 5 inches of metalling in two coats, 12 inches by 6 inches or 10 inches by 8 inches dressed Lancashire kerb laid on 4 inches to 6 inches of cement concrete, 12 inches by 4½ inches flat channels similarly laid and 2½ inches Lancashire or artificial flags for the footpaths. The minimum width of footpath allowed is 6 feet and carriageway 24 feet, but under the model by-laws which are before the Local Government Board for approval power is sought to vary in either case. Where the Council make up the street previous to adoption they do so under section 150 of the Public Health Act, 1875, and the work is carried out by administration. The cost per lineal yard of frontage for half the width of street works out at about 1*l*. 6*s*., not including sewering.

New Streets, Widenings, and Improvements.

Plate No. 1. During the past ten years the Author has carried out a considerable amount of street works of an important character by direct labour. The first of these is known as the "Globe Yard Improvement Scheme." The necessity for better communication between the centre of the town and the west end

(a district which has rapidly increased by reason of the enterprise of the silk manufacturers whose works are located at that end of the town) was becoming urgent, and the Council entered into negotiations for the purchase of "The Fields Estate," which consisted of a private residence and 11,196 yards of land, together with the "Globe" public house and other property, which cost to acquire 11,755*l.* The buildings standing in the way of the streets shown on the plan which accompanies this paper were pulled down in order to obtain access from St. Edward Street and Sheep Market, and the street now known as High Street was laid out 38 feet wide. Salisbury Street followed, and was made 38 to 42 feet wide, and provided outlet from West Street to Sneyd Street in the direction of the station, and Field Street, running out of High Street into Strangman Street, 36 feet wide. The sewers were laid, kerbs fixed, and the remaining land was then allotted for sale, and the whole, with the exception of six plots, have since been sold and buildings erected. The street works involved an expenditure of 1750*l.* 12*s.* 2*d.*, and the last instalment of the loan sanctioned by the Local Government Board, which was a short term loan, has been paid off and, with the resale of the surplus land, a much needed improvement was effected at about the cost of the street making. The surface of these streets is at present macadamised, but when the whole of the frontage is built upon a more durable material will probably be laid. The cost per foot of frontage for half width of street in the case of High Street and Salisbury Street was 17*s.* 6*d.* and Fields Street 16*s.*

The question of the erection of a new General Post Office for the town raised the matter of the widening of a narrow passage of 10 feet called Strangmans Walks (since called Strangman Street), as the Government had purchased property including a public house and property adjoining, and did not contemplate increasing the width of such passage, so the Council stepped in and, after prolonged negotiations, acquired property enabling the width to be increased to 36 feet, and thus provided another outlet from St. Edward Street to Field Street, and eventually this street will be continued to the corner of Salisbury Street and Sneyd Street. The total cost was 700*l.*

The next street work of importance was the widening and improvement of Belle Vue Road, or, as it is more recently known, "Kingsway," which connects the west end with the

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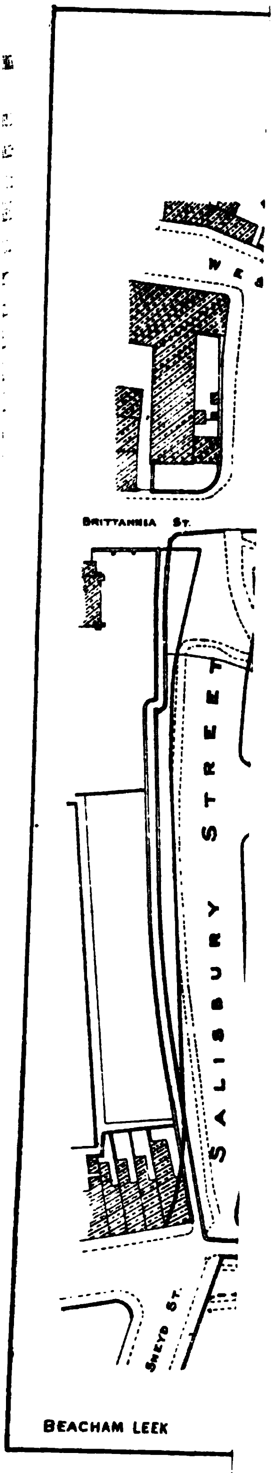

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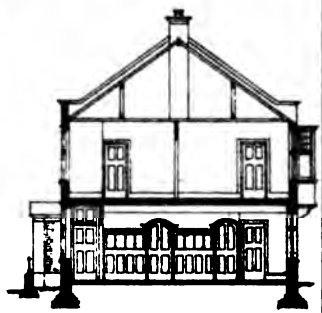
PLATE Nº 3.

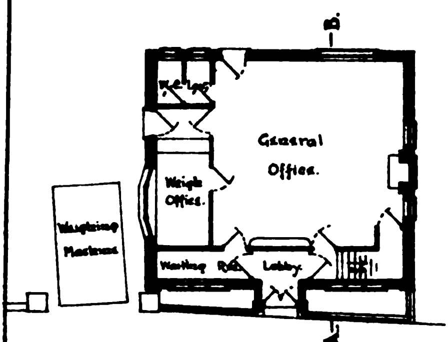
::LEEK URBAN DISTRICT COUNCIL::

::New Gas Offices::

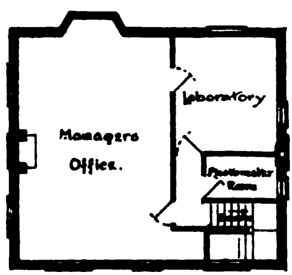
Front Elevation.



Section A:B:



Ground Floor Plan.



First Floor Plan.

Scale of 5 0 5 10 15 20 25 30 feet.

BEACHAM, LEEK.

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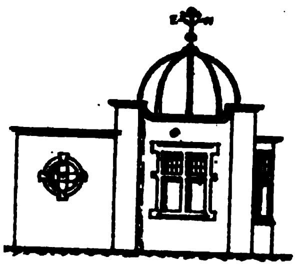
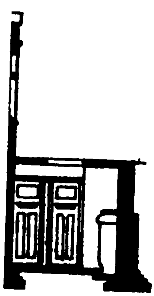
PLATE No 4.

Convenience,



Side Elevation.



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main road to Macclesfield. This was originally a narrow road of about 10 feet wide which ended in a passage about 4 feet in width. Property had been acquired by a local body called "The Town Lands Trustees" (the holders of certain properties in the town the revenues of which are from time to time to be devoted to carrying out works of improvement for the benefit of the freeholders of Leek and Lowe, after the necessary funds have been expended in the upkeep of their property) so far back as forty years ago. They completed the purchase of the last property necessary for the carrying out of the scheme in 1904, and the Author was instructed to prepare plans, sections, and estimates of cost. The scheme involved the pulling down of thirteen cottages and the widening of the road to 36 feet and 40 feet, including the erection of retaining walls, and the making of a dropped footpath to accommodate a number of cottages below the road level. The gradients vary from 1 in 10 to 1 in 24. The Local Government Board's sanction was obtained after the usual inquiry, and the Author carried out the scheme by direct labour, the Town Lands Trustees out of their income meeting the annual repayment of principal and interest. The cost of the improvement, excluding land, was 2370*l.*, and the road as widened was opened for vehicular traffic on September 13, 1906, by the late Sir Thomas Wardle, Chairman of the Town Lands Trustees, and Henry Allen, Esq., the then Chairman of the Council.

The next improvement taken in hand was to get rid of an exceedingly dangerous corner which existed at the junction of Compton and Brook Streets. The "Lord Raglan" public house and five cottages were acquired, and the street was widened from 26 feet to 44 feet, at a cost of 1600*l.*, including the acquisition of the property. The buildings were all removed and one of the cellars of the public house was utilised for the putting down of an underground convenience, which added another 250*l.* to the cost of the improvement, but it is still regarded as one of the best improvements from the public safety point of view carried out in the town in recent years. The improvements works were carried out by the regular staff, but the convenience was erected by contract.

The latest and by no means least important street improvement was that carried out at the corner of Brook Street and Russell Street by the removal and taking down of part of the

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"Sea Lion" public house and the widening of the street from 22 to 36 feet. Permission was obtained from the Licensing Bench to take in the adjoining premises for licensing purposes upon the removal of part of the public house, and the Council expended 800*l.* in effecting this improvement, being again assisted by the Town Lands Trustees to the extent of 300*l.*

Proposals for the pulling down of several properties and the widening of street corners are still under consideration.

Scavenging and Removal of House Refuse.

For the purpose of street cleansing seven men are employed, and the whole of the streets of the town are swept at least twice a week, and back passages at least once a week; while the streets in the centre of the town are constantly swept by two men, provided with handcarts for the collecting of droppings, etc.

The removal of house refuse is carried out by the Council, and a weekly collection is made. Formerly fixed ashpits were generally allowed, but of late years the Council are calling upon householders to provide moveable galvanised iron bins of sufficient size to contain a week's accumulation of refuse. Trade refuse is also removed, without any charge being made, but is not mixed with the ordinary house refuse. Four horses and carts are regularly employed in this department and four men assist as fillers.

Some years ago the Council acquired land for the purpose of erecting a refuse destructor, but a proposal was made to cart the refuse to the low-lying land part of the sewage farm with the view of same being levelled up, and no further steps have been taken in the direction of erecting a destructor. The land at the sewage farm is laid out in terraces, and previous to any house refuse being deposited, about a foot to eighteen inches of the top soil is stripped off and land drains laid, the refuse is then deposited and filled up to a height of 5 feet, the top soil is then replaced, and afterwards sewage carriers are cut, and the house refuse tip acts as a filter with very remarkable results. A few years ago when one of these acre beds had been filled up in this way, a sample of the effluent was sent for analysis to Mr. J. Carter Bell, of Manchester, with the result given below.

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CERTIFICATE OF ANALYSIS.

All results are expressed in grains per gallon.

Appearance in tube	Clear
Smell when heated to 100° F.	Nil
Total solid matter at 212° F.	136
„ mineral matter at 356° F.	131
Loss	5
Chlorine in chlorides	6·5
Nitrogen in nitrites	Heavy traces
„ nitrates	0·329
Free ammonia	2·41
Albuminoid ammonia	0·08
Oxygen absorbed in 3 minutes at 60° F.	0·04
„ „ 4 hours at 60° F.	0·12
Microscopical examination of deposit	Organic
Suspended matter	Trace
Alkalinity as free lime	Nil

The Council therefore felt justified in continuing the work of raising the level of these terraces, and while not necessarily increasing their filtration area were able to dispose of their house refuse in a comparatively inexpensive way, but it occurred to the Author that instead of further increasing the depth of the tip it would be more advantageous from a sewage disposal point of view, if the level of the 14 acres of clay and peat land which had been formerly used for broad irrigation, but had to be abandoned on account of the poor quality of the soil for sewage purification could be raised by means of the house refuse and so increase the available purification area, and this is being done, and it is hoped the same satisfactory result may be obtained. At the present time 4779 loads of house and trade refuse are being collected and disposed of annually at a total cost of 829*l.* 8*s.* 10*d.*, which is equal to 3*s.* 5½*d.* per load, and includes stripping off soil, carting away, and respreading over the refuse.

DEPÔT.

In 1891, the Council acquired 8000 square yards of land in Cruso Street, and established a depôt, erecting stabling for eight horses, loose box, harness room, mess room, cartsheds, sheds for storing material, workshops, smithy, etc., at a cost of 2570*l.*, and in 1904, erected a substantial house for the road foreman, at a cost of 250*l.* At the present time the Council own eight

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horses, four being used for house refuse removal, three on highway work, and one for sewage farm purposes. Provender account for half-year ending March 31, 1913, 173*l.* 19*s.* 2*d.*, which works out at 16*s.* 9*d.* per horse, per week.

Public Lighting.

The streets are lighted by gas, there being about 386 public lamps fitted with incandescent burners. The annual cost is 1158*l.*, which includes cost of gas, lighting and maintenance, and works out at 3*l.* per lamp, per annum.

Sewerage and Sewage Disposal.

Previous to the passing of the Leek Improvement Act, 1855, the drainage arrangements of the town left very much to be desired, and upon the appointment of Mr. Charles Slagg (the Author of several treatises on sanitary engineering and kindred subjects), as town surveyor, in 1857, the main drainage of the town was designed, and upon being submitted to Mr. Robert Rawlinson (afterwards Sir Robert Rawlinson), of the Local Government Board, was reported upon as being considered well adapted for the town. Such scheme provided for two outfalls, one for the South and the other for the North, the population at that time being about 8000, half of which drained to each district, and the work of laying down such scheme was proceeded with, and completed between the years 1859 and 1862. No treatment works were provided, the sewage being distributed over large tracts of land, and purified by broad irrigation before admission to the river Churnet. The death rate of the town at that time was 29·3 per thousand. The amount borrowed was 5300*l.*, the last instalment of which has long been paid off.

In 1892 as the result of complaints from the owners of the land on which the sewage was used of the deterioration of the value of the sewage during wet seasons by the mixture of storm water, and the possibility of having to treat the sewage by some more modern method than broad irrigation, a scheme of separating the storm water from the sewage was prepared by the laying down of separate sewers, and about ¾ths of the whole town is dealt with, and the sum of 3000*l.* was borrowed and expended for the purpose, and in the laying out of new streets duplicate sewers are called for. Another sum of 1000*l.* will be required to complete this work.

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The method of disposing of the sewage of the town by means of broad irrigation was taken exception to by the County Council, in 1896, under the Rivers Pollution Act, 1874, and pressure was brought to bear on the town to adopt some more effectual means of purifying same, and the south district was the one to be taken in hand. A firm of consulting engineers were called in, and after visits to several towns where purification of sewage by intermittent downward filtration, and broad irrigation, was in operation the Council purchased 36 acres of land, part of the Barnfields Estate, and proceeded to lay same out on the broad irrigation principle, and intermittent downward filtration, the works including purchase of land costing 10,000*l*. The sewage was allowed to pass through two very small detritus tanks, and then on to 7 acres of land the subsoil of which was sand and gravel.

In addition to 7 acres of intermittent downward filtration area, 14 acres were laid out on the broad irrigation principle, but the subsoil here was partly clay, peat, and alluvial, with the result that after some years of experience it was found that this land in the winter became sick, and in the summer months cracks were plentiful, and the sewage found its way into the under drains, and went into the river in its unpurified state, and the under drains being connected with the main carrier from the intermittent filtration area conveyed this unpurified sewage into this carrier, and thus deteriorated the already fit effluent from the better land. In 1903 the County Council again complained of the condition of things, and the Author was called upon to consider the question and report to the Council as to the best means of meeting the complaint. A full description of the works as proposed and in course of construction appeared in "The Surveyor" for September 14, 1906, so that it is unnecessary for me to dilate upon them at any length now, but will content myself with stating that the works as carried out included the laying down of two septic tanks each 100 feet long by 25 feet wide, of an average depth of 6 feet 6 inches, being 8 feet at the inlet end, and 5 feet at the outlet end, built with Staffordshire blue bricks, and coped with Yorkshire coping, concrete floor falling to central channel, and leading to sludge well at inlet end.

Scum boards, floating arms, and all other necessary mechanism was provided with sludge pump for lifting sludge on to

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sludge drying beds. The tanks are in parallel and the original roughing tanks provided were altered so as to work separately and are changed over once a week for the removal of road detritus, etc., the sticks, paper, and such-like being held back by screens at inlet end, and is removed by hand. From these roughing tanks the sewage passes to the two septic tanks which were designed to receive 100,000 gallons each, the dry-weather flow for this district, dealing with a population of 8000, being 200,000 gallons, so that practically a full day's accommodation was provided. From the septic tanks, which can either be worked together or separately, the septicised sewage gravitates to the artificial filters, or can be diverted on to the 7 acres of land laid out originally, and still worked on the intermittent downward filtration principle, and as a good effluent had always been obtained from this land it was thought inadvisable to do away with it for purification purposes, but rather to supplement it with filters, and thus seek to put out of operation the 14 acres of broad irrigation land where the subsoil was unsuitable. The filters, four in number, were constructed on the north-west corner of the broad irrigation land, being connected with the septic tanks by means of a pipe carrier. They are 60 feet in diameter and octagonal in shape, with walls of 14-inch and 9-inch brickwork, and are banked up with earth, the excavation from the septic tanks. The area of each filter is 330 square yards, making a total of 1320 square yards, by a depth of 5 feet. The floor is of cement concrete 10 inches thick as the ground was filled up about two feet, rendered to a smooth surface. Along the centre of the floor of each is a 9-inch by 6-inch channel for the purpose of collecting the effluent, and from this main channel are smaller ones 1½ inch by 1 inch, about 15 inches apart, running to the extreme end of each bed, so that it is possible to take a sample of the effluent of each bed. At each corner of the bed formed by the walls are air ducts run up of 6-inch pipes carried above the surface of the filters and covered with a grid and resting on the floor by means of a bend. The idea was that the effluent travelling along the channel to the outlets would set up an air current and would thus draw air into the filters, but experiments were tried with the view of proving whether or not this really did occur, and whether any better quality of effluent resulted. For this purpose two beds were worked together, one with open ducts and the other sealed.

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Samples of the effluent were taken and analysed, with the result that it was shown that the ducts were of no real value as far as the effluent was concerned, as the closed ones gave as good an effluent as the open ones. The filtering media is broken brick and sagger (a waste product well known in this part of the county). The main channels are grooved to receive a 1-inch perforated tile, on to which the smaller channels discharge, and on the floor of the filter for a height of 6 inches is placed broken Staffordshire brindled brick, 2-inch gauge. For the next 6 inches is 1-inch to ½-inch broken sagger, then 3 feet of ½-inch to ¼-inch gauge, and the top foot of ¼ inch to ⅛ inch. The whole washed and all dust removed and carefully graded when put in place. In the centre of each bed is a 4 feet 6 inches circular brick chamber carrying the distributor, which is of the Candy Whittaker type fitted with a mercury seal.

The necessary head for working the distributors is supplied from a tank built adjoining the filters. In this tank is one of Messrs. Adam's syphons which discharges at fixed intervals, regulated by inflow of sewage from septic tanks. The sewage gravitates to a central chamber formed by the four inner walls of the filters, rises up a pipe, and thence to the distributors, each of which is controlled by a valve. The filtrate from the four filters is conveyed to one outlet and thence to the river, or it can be distributed over the broad irrigation land. For the reception of the sludge which accumulates in the septic tanks a sludge-drying bed is provided, into which the sludge can be pumped from both sets of tanks. The size of this bed is 100 feet by 28 feet, giving a superficial area of 2800 square yards, by a depth of 2 feet. Along the floor is laid a pipe drain with branches every 2 feet apart, laid herring-bone style of butt-jointed pipes. Around and upon these pipes is placed a layer of hand-packed cinders or clinker ashes of 1½-inch to 1-inch gauge, and 6 inches deep, then another layer of 1-inch to ½-inch gauge, and a top coat of ½ inch to ¼ inch ashes, all screened, making a total of 2 feet. At the outlet end on the 6-inch main drain is placed a draw-off arrangement whereby the sludge effluent is conveyed into the roughing tanks. The sludge is disposed of by allowing an adjoining farmer to cart it away for manuring purposes, and the demand made is quite equal to the supply, so that no cost is incurred by the Council in getting rid of the sludge.

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In order to separate any quantity above six times the dry-weather flow of the sewage a weir was placed in the main sewer which passes at the rear of the goods station of the North Staffordshire Railway and side by side with the storm-water outfall, which discharges into a carrier connected direct with the river, so that all above the six times pass into the storm-water sewer, and on the farm adjoining the roughing tanks a manhole is built and a penstock fixed and locked, so that only three times the dry-weather flow pass to the tanks and is dealt with on land and filters, the other three times being dealt with as storm water on the 14 acres of irrigation land, so that it is possible to comply with the requirements of the Local Government Board by disposing of the storm water on a special and separate area of prepared land other than that in use for the treatment of the effluent from the ordinary tanks and filters. The local sewage is not purely domestic, as it contains, especially at certain times of the day, considerable quantities of dye-water which is turned out from the various mills and dyeing factories connected with the silk industry, but it has been shown that the dye-water, although it contains a quantity of logwood, is amenable to septic treatment and a satisfactory effluent is obtained. The amount borrowed for these extensions was 5200*l*. The new works have now been in operation for 6½ years, and monthly analysis of the effluent is prepared by Mr. J. Carter Bell, the borough analyst of Salford, and circulated to the members of the Council. For some months after tanks and filters were started the effluent did not reach a very high standard of purity, but they gradually improved, and below are given copies of the analyst's report of the third, sixth, and twelfth months after, compared with its condition in January of this year, from which it will be seen that, with efficient management and periodical resting of the filters, a high standard of nitrification is reached.

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ANALYST'S REPORT.

All results are expressed in grains per gallon.

Bacterial filter effluent.	Third month.	Sixth month.	Twelfth month.	January, 1913.
Appearance in tube	Fairly clear	Cloudy	Clear	Fairly clear
Odour	Earthy	Faint sewage	Nil	Earthy
Total solids at 212° F.	40·6	38·0	43·0	45 0
" " 360° F.	38·6	37·0	40·0	40·0
Loss	2·0	1·0	3·0	5·0
Chlorine	5·5	7·5	6·0	6·5
Nitrogen in nitrites	Nil	Traces	Traces	Trace
" nitrates	1·55	0 032	1·9	2·88
Free ammonia	2·0	7·0	0·24	0·18
Albuminoid ammonia	0·06	0·28	0·08	0·6
Oxygen absorbed in 3 minutes at 60° ..	0·96	0·36	0·13	0·11
" " 4 hours " ..	1·8	1·05	0 52	0·31
Alkalinity calculated as free lime ..	Nil	Nil	Nil	Nil
Deposit	Organic	Organic	Organic	Organic
Suspended matter	6·8	0 3	Nil	Trace

The number of hours each bed has worked during every twelve months is 4380, the number taken in the year being 8760, and the quantity dealt with has been 120 gallons per square yard per twenty-four hours, or at the rate of 580,800 gallons per acre. Experience has proved to us that it is possible to deal with a strong sewage on fine grade filters, provided septic tank provision is adequate, the exact quantity that the filters are capable of dealing with being carefully ascertained, and kept to, and requisite periods of rest given, and all that is necessary to do during such periods of rest is to lightly fork over the beds, and then allow them to aerate, and though our area of filters is very small, the knowledge we have acquired of their working is likely to be of immense service to us when we come to extend, which may be in the very near future, in order to relieve the farm of the large quantity of sewage put upon the intermittent land, and which is so large in volume as to render it exceedingly difficult to satisfactorily farm the land, to say nothing of what may have to be done at the north end of the town, though we hope that such a large expenditure as may be involved in the construction of new works for that district may be for many years postponed, having regard to the fact that good use is made of the sewage for purposes of irrigation, that there is a demand

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for it, and that its distribution over large tracts of land is such that no nuisance or pollution occurs.

The distributors installed have worked continuously since they were fixed without giving the least trouble, and experiments were tried to prove the efficiency of the distribution, with every satisfactory result, it being clearly demonstrated that each square yard of filter area received an equal amount of sewage. The intermittent land, as will be observed upon inspection, is all laid out in beds, with grips or channels every 5 or 6 feet apart, into which the septic effluent is passed, and ox cabbages and mangolds are planted, and the produce realises a good sum annually, though like most sewage farms the creating of a revenue is not the first thing looked for, but the disposal of the sewage with as little nuisance as possible, and though the quantity of sewage put upon the land is more than is necessary to grow the crops the farm does not suffer for want of efficient management.

The other half of the town is drained to what is known as the north district, and the sewage is utilised upon about one hundred and fifty acres of land. The farmers in that district attach great value to the proper use of the sewage, and a man is kept there whose duty it is to constantly wash the meadows with it from open and pipe carriers, and being far enough from any population no complaints are made. The town having extended in a westerly direction, and beyond the point where it is possible to connect with either the south or north outfalls, a main sewer for this district is in hand, costing 800*l.*, by which means the coupling of the western with the northern district is secured.

Water Supply.

In the matter of water supply the town of Leek must be considered exceedingly fortunate, thanks to the foresight of the old Commissioners. In the year 1857 the water undertaking was purchased from the Earl of Macclesfield for 11,000*l.*, the purchase money being allowed to remain on mortgage of the property. This has long ago been paid off, and considerable extensions and improvements of the undertaking carried out. In the year 1861 the Commissioners found it necessary to adopt measures for protecting the water rights of the town, in view of the fresh powers of the Staffordshire Potteries Water Co., and after application to Parliament they were able to do this.

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In the year 1862 additional supplies were obtained and arrangements made with the millowners on the River Churnet whereby the water should be provided elsewhere for that taken, which was done by the construction of a surface collecting reservoir at Blackshaw Moor, carried out by Mr. Bateman, C.E., at a cost of 2700*l.* In 1871 the Commissioners still further increased the supply by collecting certain springs at Upperhulme, belonging to the Earl of Macclesfield and Sir John Harpur Crewe, Bart., and in the year 1893 other rights were acquired for the sum of 1700*l.*, whilst in the year 1904 still further rights to collect water were obtained from the Condyliffe trustees in perpetuity at 1*l.* a year.

The works themselves are of the simplest possible character, and few towns can, I think, boast of a better or more abundant supply. The supply takes its origin in a series of deep springs in the millstone grit of the Roches, situate at a distance of 4 miles from the town at a level of 950 feet above ordnance datum, and is supplied to the town by gravitation. Each of the springs, seven in number, are built around in brickwork, and protected by means of heavy stone covers, securely locked to prevent contamination of any kind. The water is conveyed to the town by means of an 8-inch cast-iron main, and the springs are coupled direct to such main, the only storage provided being a reservoir situated on the outskirts of the town, at a level of 745 feet above ordnance datum and of 2,000,000 gallons capacity. This reservoir only serves when the daily supply from the springs is diminished after a long period of drought or very excessive consumption in the town, and so the pressure in the mains is kept up. At night, when the consumption is considerably lessened the water backs up in the main, shutting a reflux valve fitted in the bottom of the reservoir, and rises to the height of 790 feet above ordnance datum, and filling a small tank built to supply the houses at the highest part of the town, the overflow from which is connected to the larger reservoir, and again fills this up in readiness for a heavy demand. At the lowest of the series of springs at Upperhulme a large brick-collecting chamber is built, fitted with a gauge, by which means it is possible in summer time to ascertain the quantity passing to the town, and upon which the amount of compensation water is calculated, being half a gallon for every gallon taken from the springs. This compensation water is collected from the moorlands at

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Blackshaw, and stored in two reservoirs, one of which was constructed in 1862, as previously stated. In addition to these two there is a third compensation reservoir situated at the east end of the town, which is supplied by water collected from the surface springs in the immediate vicinity, and from an overflow taken from the 2,000,000 reservoir at Mount Pleasant. At each of the reservoirs gauges are fixed and valves set, discharging the ascertained quantity of compensation water into the streams that supply the River Churnet. At a point on the boundary of the town the 8-inch main is divided into two 6-inch mains, one supplying the higher and the other the lower parts of the town.

Copy of Analysis made, March, 1911, by J. Carter Bell, Borough Analyst, Salford.

All results are expressed in grains per gallon.

Appearance in tube	Clear
Smell when heated to 100° F.	Nil
Total solid matter at 212° F.	7·4
" " 356° F.	7·0
Loss	0·4
Chlorine in chlorides	0·7
Phosphoric acid	Nil
Nitrogen in nitrites	Nil
" nitrates	0·06
Free ammonia	Nil
Albuminoid ammonia	0·0021
Oxygen absorbed in 15 minutes at 60°	0·0112
" " in 3 hours at 60°	0·0252
Hardness, Clark's scale, before boiling	4·2
" " after "	3·2
Soap destroyed by 1 gallon of water	Under 50
Microscopical examination of deposit	Heavy traces of organic
Poisonous metals	Nil

This is a first-class water of a high degree of purity. The mineral matter is as follows:—

Carbonate of lime	2·8 grains per gallon.
" magnesia	0·25 " "
Sulphate of "	1·64 " "
Sodium chloride	1·31 " "
Sodium carbonate	1·50 " "

During the past ten years there have been many improvements effected in the distribution. Difficulties were experienced in filling up the high level tank at night, resulting in the necessity of turning off at night the whole town for certain hours, but

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this was remedied by removing a gauge, which was placed about two miles from town at Blackshaw Moor, at 810 feet above ordnance datum to Upperhulme at 850 feet above ordnance datum, thus obtaining 40 additional feet of head. Attention was then given to the question of turning off in the town for repairs. It was formerly the practice to turn off every Thursday, and on account of the absence of the necessary valves the area affected was much greater than there was any real necessity for, and complaints were frequent, especially as manufacturers had of late become more dependent upon the town supply, having abandoned their own wells in favour of town water. To overcome this difficulty sixty new valves were inserted in the mains where required, thus enabling each street to be separately controlled, and it is not now the practice to turn off the main supply except for main repairs, and manufacturers are saved great expense in not being called upon to provide a large amount of storage. All mains are drilled, tapped, and ferrules inserted under pressure.

Instructions were given to the Author in 1907 to consider the question of laying an additional main 8 inches in diameter from the springs to meet demands of manufacturers for additional supplies and to provide for the growth of the town, but before dealing with such a large expenditure as this involved attention was called to the necessity of ascertaining the amount of waste, and for this purpose the Author obtained the necessary permission to institute the system of waste detection by means of Deacon meters. The town was divided into eight separate districts, each to be supplied through a Deacon meter, and at the same time an 8-inch bulk meter was inserted on the trunk main where it entered the town at the boundary. From the diagrams it was ascertained that considerable waste was going on, and steps were taken to reduce it. Four districts were put in hand, and meters inserted, the result being that since 1908 the question of an additional main has not been raised, and during the summer of 1911, when most authorities were becoming anxious respecting their water supply, not the slightest inconvenience was experienced here, and we were quite able to meet all the demands of both domestic and manufacturing consumers without any restrictions whatever, largely increasing our revenue, and since we have been compelled to throttle the supply coming from the springs in order to prevent the storage reservoir overflowing its banks.

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House to house inspection is carried on with the use of the stethoscope, all repairs are carried out by authorised plumbers, their work inspected before being covered up, and a set of regulations strictly enforced. The consumption which was originally 30 gallons per head, is now in the metered districts 15 gallons to 18 gallons per head per day. At the time of the purchase the price charged for domestic supply was 1*s.* in the £. In 1879 it was 11*d.*, and in that year was reduced to 10*d.* on all assessments at more than 5*l.*, and in 1882 a further reduction to 9*d.* was made, and in March, 1888, to 8*d.* on the rateable value instead of the annual value. This price obtained down to 1910, when it was reduced to 4*d.* in the £, at which it stands to-day, and the sum of 1500*l.* is annually handed over to the reduction of rates after paying all administration charges and giving a free supply to public baths and all other public purposes. The price charged for manufacturing or trade purposes is 8*d.* per 1000 gallons, by meter, and the demand in this direction is considerably increasing. When the Leek Improvement Commissioners vacated office in 1895 upon the creation of the Urban District Council, the figures relating to the purchase and improvement of the water undertaking of the towns were—

	£
Bonded debt	20,900
Paid off	18,800
Balance owing	2,100

This amount was paid off in less than four years, since when the undertaking has contributed largely every year to the reduction of rates in addition to supplying water at a figure which will rank as one of the lowest, if not the lowest, in the country. (It will be interesting to members of this Institution to know that the Chairman of the Water Committee of this Council for many years was the late John Nesham Platt, the father of one of our most respected members, Mr. S. S. Platt, Borough Surveyor, of Rochdale.)

Gas Supply.

In the year 1828, the town was supplied with gas, the works having been built in 1826 by a Joint Stock Company, the price for gas being 12*s.* 6*d.* per 1000 cubic feet, which though it may be considered high was less than paid in Manchester at the time, viz.: 14*s.* In the year 1845, the Commissioners under

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the old Act purchased the works for 6194*l.*, and under the 1855 Act they became vested in the Improvement Commissioners, the price of gas being then 6*s.* per 1000 cubic feet, and the annual make 3½ million cubic feet. Since then the works have been considerably enlarged, and in the year 1898–9 consequent upon the increased demand, the whole works were rebuilt on the most up-to-date principle at a cost of 20,000*l.* The annual make of gas has increased to 109,000,000 cubic feet, and the net price to consumers is now 2*s.* 2*d.* per 1000 cubic feet, and up to the year 1910, the streets were lighted free, and considerable sums handed over to the rates, though no charge is made for meters, and services are laid up to the houses free. Since 1903 the Author has been responsible for extensions to the retort house, coalstore, erection of coal-handling plant buildings, including subway under county main road, and new offices, the latter of which have just been completed; and it is claimed that the town possesses one of the most up-to-date gas undertakings in the county.

Description of Coal-handling Plant.

Plates Nos. 2 and 3. Previous to the putting down of this up-to-date plant, the coal used for gas-making, about 10,000 tons per annum, was carted from the Railway Company's sidings to the works, and then by means of a winch was taken up an inclined way to the coalstore. It was only possible then to buy gas nuts, and the cartage was considerable, averaging 1*s.* a ton, as each load had to be weighed over the machine when passing into the works. It was originally intended to have an overhead transporter or conveyer, but in 1902 this idea was abandoned in favour of an underground. The Author in conjunction with Messrs. W. J. Jenkins & Co., of Retford, the Plant Contractors, prepared plans, etc., and the work was eventually carried out as follows. The railway company's sidings were continued to a site adjoining coal breaker pit, and now each truck is weighed as it comes in, and again empty as it goes out. The truck passes on to the edge of the pit where a tipper, worked by a 22 h.p. gas-engine, comes up and catching the truck under the back axle tips the contents into a hopper. The coal then passes through a breaker where it is broken to sizes suitable for gas making, and is discharged on to an endless balata belt, which travels up through a subway, constructed under the main road from the

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Potteries to Leek, into the gas yard, and thence to the top of the coal store.

The gas engine works a capstan for moving the trucks from the siding over the weighing machine, and to the breaker pit, the tipper, breaker, and belting, and thus effects a great saving of labour in handling. The breaker pit is 20 feet deep, built of Staffordshire blue bricks in cement, and the subway is 6 feet 6 inches wide, by 6 feet high, the side walls being 14 inches thick with semi-circular three-ring arch. The inclination of the subway is 1 in 2·4, the floor is of Portland cement concrete, with strengthening cleats every 15 feet apart. A flight of steps is formed in the concrete on one side of the subway, leaving sufficient room for the standards supporting the rollers carrying the belting, so as to afford facilities for oiling the roller bearings and to give access to the plant from the gas works yard, without coming out of the works. An engine house encloses the gas engine, which is one of the National type, and a corrugated roof with steel framing covers the breaker pit and belting, from the outlet of subway in gas yard up to coal store roof level. The plant has been in use since 1907, and must have effected a great saving in coal handling, as it enables the Council to buy its coal in the open market, do its own crushing, and in conjunction with the appliances such as conveyers and mechanical stokers provided at the works forms a complete system of coal-handling machinery. The cost of the plant and buildings amounted to 2650*l.* The new gas offices adjoining the works, which have just been completed, contain on the ground floor, weighing machine, attendant's office, waiting-room, general office, w.-c. and lavatory, and on the first floor, manager's private office laboratory, and photometer room. The same are built with Accrington facing bricks and Roche stone dressings, and cost 625*l.*

Electricity Supply.

The history of this, the infant undertaking of the Council, dates back to the year 1899, when the Council, rather than allow the first private company to erect works and supply electricity for the town of Leek, applied to the Board of Trade for the requisite powers for themselves to carry out these objects, and a Provisional Order was obtained in June of 1900 upon the advice of their consulting engineers, Messrs. Burstall and

Monkhouse, of London, and in 1902 the sanction of the Local Government Board was given to a loan of 10,061*l.* for the purpose. The site selected for the generating station was a part of the land acquired by the Council adjoining the town depôt. The original building consisted of an engine room 39 feet by 37 feet, motor room 37 feet by 17 feet, battery room 42 feet by 16 feet, engineer's office 16 feet by 10 feet, and mains store 24 feet 6 inches by 16 feet, with workshop 16 feet by 16 feet. The Author supervised the erection of the station and has since extended it at a cost of 2150*l.* and laid the cable conduits in all the streets included in the area of supply. The engine room was excavated to a depth of 10 feet, and as the ground was originally a tip, a raft of concrete 2 feet 6 inches thick was laid over the whole area, and from this raft was constructed the beds for the engines.

The Author is indebted to the Council's electrical engineer, Mr. R. M. Carr, M.I.E.E., for the following information respecting the plant:—The generating plant in connection with the original scheme were No. 2 Stockport horizontal gas engines, coupled direct to 10-pole kilowatt direct current dynamos by the Industrial Engineering Company. The engines were driven by town gas from the Council's gas works, through a special 6-inch main direct from the gasholders. In 1906, owing to the increasing demand, it was found necessary to install a further plant, and a five-cylinder vertical Campbell gas engine was installed in conjunction with a 125 kilowatt industrial dynamo. Both this and the Stockport engines work upon the ordinary "Otto" cycle, but are throttle governed. In 1908 additional plant being found necessary, it was decided to install a double acting two-cycle "Korting" engine by Messrs. Mather & Platt of 275 H.P., coupled to a 175 kilowatt dynamo by Messrs. Siemen's Bros.

The town gas now consumed being well over a million feet per annum, a producer gas plant was installed, and all the engines formerly consuming town gas were adapted to use the lower grade gas, the town main connections being left as a standby. The gas plant installed is of the "Wilson" type, manufactured by the Horsehay Co., Limited. It consists of two producers, each of 300 H.P., with dust catchers, coolers, washing, and purifying plant to deal with a load of 500 H.P. There is also a small holder which is, however, not intended as a

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reservoir, but merely as a mixer and regulator of pressure. By this means a regular and even quantity of gas is maintained. Bituminous coal is burned in the producers, and it is interesting to note that Leek is the only municipal electricity undertaking in the country using a bituminous gas plant. The only by-product recovered is tar, which is sold to refiners. Further extensions being found necessary in 1911, a Diesel oil engine of 300 H.P. was installed, together with a dynamo of 220 kilowatts. The engine is by Messrs. Cauls, of Ghent, and the dynamo by Messrs. Crompton & Co.

The supply in Leek is upon the three-wire direct current system with a declared pressure of 460 volts for power purposes and 230 volts for lighting. The station pressure varies between 480 and 500 volts in accordance with the demand. A D.P. battery of 400 ampere hours' capacity is installed together with the usual auxiliary plant in the way of balancers, boosters, and milkers. The distributing network is supplied by means of five trunk feeders which carry the current in bulk to centres of distributors, pilot cables being carried back to the station to show the pressure at the feeding points. Normally, these centres of distribution are interconnected through fuses, so that should a fault occur the fuses give out, and only the supply in the immediate vicinity of the fault is disorganised. The mains laid under the original contract were paper insulated, bitite sheathed, triple concentric cables, drawn into stoneware conduits, but the whole of the extensions are simple conductor cables laid solid in bitumen and wood troughing.

The demand for electricity has been steadily increasing since the supply was commenced, and the following table shows the growth of the demand.

Year ending	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.
Units sold	14,207	58,390	96,696	179,742	315,518	364,363	413,556	522,416	620,262

The supply is principally for power purposes, and although the average price obtained per unit for all purposes is only 2·1*d*. the undertaking is able to show a surplus after meeting all charges including interest and repayment of capital.

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MARKETS.

On November 23, 1208, in the reign of King John, 9th year, a charter was granted to Ranulph Earl of Chester to hold a market every Wednesday and one fair annually on the third day before the Feast of St. Edward, March 18, Festival. In 1855 the market rights and tolls were purchased by the Commissioners for 4412*l.* including cost of transfer. From that period to 1874 the Cattle Fairs were held in the streets. In 1872 the site of the present Smithfield was purchased, and in 1874 laid out and fenced. The expenditure in connection with the markets proper was 7100*l.*, and in 1894 the last instalment of debt in connection with the market rights was paid off, and they became the property of the town, free from debt. In 1877 a shade which had been used for silk twisting and seven cottages were purchased as an adjunct to the markets and for use in connection with the Smithfield. The shade was converted into a coffee tavern, and on the ground floor settling rooms were provided for users of the Smithfield. The total area covered by the Smithfield is 9216 square yards, which include areas for cattle, horses, sheep, calves, and roads. To the east of the Smithfield is the Pig Market, covering an area of 1534 square yards. In 1896 the Council erected the Butter Market together with the market shops, conveniences, etc., at a cost of 2289*l.* The market covers an area of 382 square yards, and is crowded weekly with buyers and sellers of agricultural produce brought in from the surrounding country side. In 1902 provision was made for the reception and sale of poultry by the erection of the Poultry and Fowl Market, covering an area of 342 square yards at a cost of 1000*l.*, with approaches from the Market Place and Derby Street. On Wednesdays a large open market is held in the market-place, and it is claimed that Leek is one of the best attended markets in the county, and is second to Nottingham as the largest open market in the country. The markets yield a good sum to the relief of the rates annually after all the charges are met, and add considerably to the prosperity of the town.

TOWN HALL.

In 1884 the present building was purchased for 5300*l.*, and in 1887 was altered to accommodate the different Municipal departments at an additional cost of 2770*l.* On the ground

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floor is provided accommodation for the Clerk, Collector, and Surveyor's departments, and on the opposite side of the entrance is the Council Chamber. On the first floor is the Assembly Room, size 74 feet by 37 feet, with ante-rooms, cloak-rooms, etc., while at the rear is the caretaker's house and a large piece of ground reserved for extensions.

Isolation Hospital.

In 1874 the Isolation Hospital was erected at a cost of 2610*l.* including land. The accommodation provided was for twelve beds, in two pavilions, with administration block, separating them, and laundry, mortuary, etc. In 1905 the Author was called upon to prepare plans for extensions comprising accommodation for six additional beds, the conversion of one-half of one pavilion into three separate observation wards, a nurse's home, with matron's sitting-room and three bedrooms and bathroom, and a discharging block with undressing-room, bathroom, dressing-room, and friends' waiting-room. The contract for the work was 2200*l.*, and the work was completed under the Author's supervision in 1907.

Cemetery.

The Council possess a beautifully situated and well-laid-out cemetery acquired at a cost originally of 4200*l.* It contains two chapels. In 1889 additional land was acquired and 3500*l.* was spent, including the laying out, and last year an additional two acres of land were purchased. The total area is just under twelve acres and will more than meet the needs of the town for the next thirty years. The subsoil is red sandstone.

Fire-engine Station.

The Town is served in time of fire by a very efficient Fire Brigade housed in an up-to-date station in Stockwell Street. The present station was erected in 1897 at a cost of 1040*l.* It contains a steamer, by Messrs. Shand, Mason & Co., two manuals, fire escape, chemical extinguisher, and hose cart. In order to more effectually deal with any outbreak of fire and to obtain the use of the steamer, water-tanks, about 5 feet square and 8 feet deep, are built at different parts of the town coupled to a 6-inch water main. These are to be used exclusively for

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fire purposes, and are inspected and tested monthly and kept in complete order. Adjoining the fire station is the caretaker's house.

ALLOTMENTS.

Garden allotments totalling 6·25 acres are provided at different parts of the town which are let at 2*s.* 6*d.* per garden rod (64 square yards). The income is sufficient to meet the interest on the purchase money. Of the above total 1·14 acres are on lease. Water is taken on to the allotments and charged for at 3*d.* per garden rod extra to rent.

RECREATION GROUNDS.

The town possesses two recreation grounds, 10 acres in extent, 2½ of which are on lease, at an annual rent of 16*l.* Of the other 7½ acres 2½ were acquired by the Council in 1879, and in the year 1887, on the occasion of the Jubilee of Her late Majesty Queen Victoria, the other 5 acres were presented to the town by the late William Challinor, M.A., of Pickwood. At each of the grounds swings and other games, conveniences, etc., are provided. Roads and paths are tar paved, and suitable parts planted with trees and shrubs. The latest addition to the open spaces of the town is one which comes to the inhabitants by the munificence of William S. Brough, Esq., who during the early part of the year conveyed to the Council free of cost 10½ acres of land, part of the Ball Haye Estate, to form for ever a public park and recreation ground, and the Author is at present engaged upon plans for its laying out. The town may therefore be considered as amply provided with open spaces, thanks largely to the generosity and public spirit of two of its leading citizens.

PUBLIC CONVENIENCES.

Plate No. 4. During the last few years three public conveniences have been provided, two of which are built underground. When one of the public improvements referred to, viz. that at the junction of St. Edward Street, Brook Street, Broad Street, and Compton was carried out the pulling down of a public-house left part of the basement beyond the line of the widened street, which was converted into a public convenience, consisting of two W.-C.'s and a six-stall urinal. The old walls were lined throughout with white glazed bricks, and steps provided, the above

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portion being enclosed with railings, inside which shrubs, planted in tubs, are placed, thus acting somewhat as a screen. On the site of the present town weighing machine at the end of Derby Street formerly stood a weigh-office, and at the rear, above ground, a very poor specimen of a convenience, consisting of three slabs only, without any covering whatever. Plans were prepared by the Author for a new weighing-machine house, above ground, and at the rear a porch way containing the steps leading down to the convenience, for gentlemen only, consisting of two W.-C.'s and six stalls. The building, standing as it does in the centre of a large open space, needed to be somewhat agreeable in character, with elevations to three streets and the entrance at the rear. The building as designed, it is hoped, meets the necessity, and is built of Accrington bricks, Roche stone dressings, and covered with a copper dome on the top of which is a weather vane. The convenience itself is lined with white glazed bricks, the roof is steel and concrete, light obtained by means of prismatic lights, and floor is laid with Venetian Mosaic terazzo paving. An area of land at the rear was enclosed with iron railings, and seats provided therein, and, in order to add to its appearance, shrubs planted in tubs are placed therein, and towards this cost the Town Lands Trustees again contributed the sum of 120*l.*

The third convenience is at the junction of West Street and Mill Street. The awkwardness of the site was a source of trouble in deciding the kind of building to erect, and the Author designed a building octagonal in shape, above ground, with steps leading up out of Mill Street into West Street, with the entrance on the back side. The walls are of Accrington bricks, Roche stone dressings, and the roof covered with lead, on the top of which is a wooden ventilator covered with copper. At the front is a small space enclosed with wrought-iron railings, inside which are shrubs, as in the other cases. The accommodation provided is two W.-C.'s and six stalls. The walls are lined with white glazed bricks, ceiling is of pitch pine, and floor of terazzo paving. In the three cases the electric light is installed. The cost of the three conveniences was 1000*l.*

NICHOLSON INSTITUTE, PUBLIC LIBRARY, TECHNICAL SCHOOLS, AND GYMNASIUM.

The Public Libraries Act was adopted by the Commissioners in 1887, and the handsome building with its copper top which

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can be seen for miles around, and known as the "Nicholson Institute," was built by the late Joshua Nicholson (the father of the present Sir Arthur Nicholson), and supplied with books, at a total cost of 20,000*l.*, and was taken over by the Commissioners. For the first ten years Mr. Nicholson's family contributed 200*l.* annually towards its maintenance. Since then it has been maintained out of the rates, though Sir Arthur Nicholson has contributed considerable sums annually, besides paying sums for repairs, etc. On the ground floor is provided large news room, 40 feet by 25 feet; magazine room, 48 feet by 25 feet; and lending library, 40 feet by 19 feet. This department is erected on the tier principle, between the news and magazine rooms, and this arrangement affords observation of both large rooms by the attendant in charge of the lending department. In the basement is carried on the Art School, in connection with the technical instruction work, while on the first floor is the museum and picture gallery. In 1900 the Council erected on land they had acquired adjoining the Nicholson Institute, the Technical Schools and High School (which were opened in July, 1900, by Her Most Gracious Majesty Queen Mary); and workshops were fitted up with looms, etc., so that opportunity was afforded to the youth of the town to acquire technical instruction in matters affecting the staple industry of the town.

In 1900 the foundation stone of the William Carr Gymnasium was laid by His Most Gracious Majesty King George V. (then the Duke of York). The building was erected by a well-known inhabitant of the town, the late William Carr, who bore the whole cost, including the fitting up, and presented it to the town, so that these buildings, representing an expenditure of 30,000*l.*, are a standing monument to the generosity of private individuals, and a public spirited authority, who have placed before the youth of the town the opportunity of improving both mind and body, and at the same time the obligation to use the means thus provided. The work of an efficient high school is carried on in the school buildings, a work well known and appreciated throughout the county. Plans are being prepared by the Author for extensions to the art department, consisting of modelling rooms and art metal department.

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PUBLIC BATHS.

So far back as 1853 the question of the provision of public baths was decided upon, and in 1854 the present baths were opened to the public, the same having been built partly with money borrowed on the security of the poor rates. The cost of the site and erection was 2422*l.* 17*s.* 4*d.* In 1874 the Improvement Commissioners took over the management of the baths, the original loan having been paid off during that year. In 1881 and 1894 a piece of land in area about one hundred and seventy-two square yards and two cottages and workshop were purchased for extensions for 655*l.* 16*s.* 6*d.* In 1896, 1240*l.* was expended in extensions, and 260*l.* in providing new boiler, and the last annual repayment of this loan will be paid off in 1927, while the loan for boiler will be paid off this year. The existing accommodation provided is ten gentlemen's, and six ladies' slippers. Large swimming bath, average size 59 feet 6 inches by 21 feet 6 inches by 4 feet 4 inches deep; second class bath, 37 feet 6 inches by 22 feet by 3 feet 3 inches deep. Living accommodation for caretaker, consisting of living-room on ground floor, three bedrooms on first floor, and kitchen in basement. In the basement is also provided boiler house, containing Cornish boiler, 14 feet long by 4 feet 6 inches diameter; feed pump, two Royle's calorifiers, and towel-drying chamber. To such a degree has the art of swimming appealed to the youth of the town, that there are clubs in connection with almost every Church and Society, and last year the Council were petitioned to consider the question of enlarging the baths, and the Author was called upon to prepare the necessary plans and estimates, and alternatively the erection of new baths on another site. These were in due time presented to the Council, but for the present in view of the existing debt on the present baths no further steps have as yet been taken. The question must sooner or later be dealt with, and with the object of making the discussion on this paper as useful as possible, the Author has ventured to submit these plans for the kindly criticism of the members, believing that it is more to the point to obtain the benefit of kindly criticism before their erection than after, when it will be too late to profit by many of the suggestions that may be made.

Plates 5 and 6 show existing baths and proposed reconstruction and remodelling, providing first class swimming bath,

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75 feet long by 30 feet wide, and of an average depth of 5 feet, being 6 feet 6 inches at deep end and 3 feet 6 inches at shallow end. Forty-nine dressing-boxes are proposed for first-class bath. Second-class bath, 38 feet long by 21 feet wide, and of an average depth of 4 feet 3 inches, being 5 feet 6 inches at deep end and 3 feet at shallow end. Twenty-four dressing-boxes are proposed to be provided. The usual offices, consisting of two W.-C.'s and a three-stall urinal for first class and one W.-C. and a three-stall urinal for second-class bath. No alteration is suggested to gentlemen's slippers, but reconstruction of ladies' slippers is intended. For the purpose of accommodating spectators on occasions of competitions, a balcony is to be provided, constructed over dressing-boxes on three sides of the bath, with an exit into a side street, and will provide accommodation for 400 to 500 spectators. The proposed enlargement will necessitate a new Lancashire boiler, 16 feet by 6 feet diameter, capable of evaporating 2250 lbs. of water per hour, and a new chimney 75 feet high, with a flue area of 3½ square feet. It is proposed to install a continuous filtration and aerating plant by Messrs. Royle's, the filter, strainer, pump, and reheater being accommodated in the basement, and the aerator in a satisfactory position on the roof. The estimate of this reconstruction was 4685*l.*, and filtration plant 675*l.*

Plates Nos. 7 and 8. The plans for complete new public baths on another site which accompany this paper, show accommodation on the ground floor, consisting of twelve gentlemen's, and seven ladies' slippers, ticket office, waiting-rooms for both sexes, superintendent's office, and first- and second-class swimming baths. The first-class bath is 75 feet long by 30 feet wide, of an average depth of 5 feet, being 6 feet 6 inches at deep end, and 3 feet 6 inches at shallow end. Second-class bath 50 feet long by 20 feet wide, of an average depth of 4 feet 3 inches, being 5 feet 6 inches at deep end, and 3 feet at shallow end. Six foot baths with shower over are provided to each bath, fifty-two dressing-boxes to first-class bath, and 39 to second-class, and two W.-C.'s, and a three-stall urinal to each. A separate entrance to second-class bath is shown for school children, off a proposed 10 feet road. Balcony is provided over dressing-boxes approached from main staircase, to hold 400 to 500 people with a separate exit on to side passage. The living accommodation intended

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on first floor is kitchen, 14 feet 6 inches by 9 feet; scullery, 10 feet 6 inches by 7 feet; two bedrooms, 11 feet by 12 feet 6 inches, and 13 feet by 9 feet; and W.-C., in addition to sitting room on ground floor, 11 feet 6 inches by 10 feet. In the basement will be accommodated a Lancashire boiler, 18 feet by 6 feet diameter, capable of evaporating 2500 lbs. of water per hour, with feed pump, calorifiers, engineer's workshop, coal bunkers, drying rooms, and establishment laundry, fitted with mechanical washers, wringers, and lift for towels. Provision is also made in the basement for filter, strainer, pump, and reheater, in connection with filtration plant, and aerator will be fixed on roof. The chimney will be 80 feet high, with internal area of 4½ square feet. Heating to waiting-rooms, corridors, etc., will be by means of radiators. The estimated cost is 9500*l.*

Proposed Housing Scheme.

By instructions of the Council the Author has just recently prepared a housing scheme for the erection of 42 cottages with plans, estimates, etc., involving an expenditure of 10,550*l.*, but private enterprise realising the need of providing more housing accommodation in the town is endeavouring to meet the demand, and it is hoped that the Council may not be called upon to carry out the scheme.

The Author would like to take this opportunity of expressing his indebtedness to the members of his staff, Mr. Wm. Slater and Mr. H. Garside, for the kind assistance rendered in the preparation of this paper and plates, and trusts that the members of the Institution will find sufficient in the paper and works inspected to repay them for the time and trouble taken in visiting a small town, but little heard of, though none the less important, and which he is sure will not be considered as being very far behind some of the larger towns in municipal enterprise and endeavour.

DISCUSSION.

Mr. W. Plant: I have much pleasure in proposing a hearty vote of thanks to Mr. Beacham for his excellent paper. It is very complete and extremely interesting. If studied in connection with the admirable drawings, we cannot help but

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derive considerable benefit. I quite agree with Mr. Beacham that a 10-ton roller is too heavy for ordinary tar macadam work. I have found it so; but a 10-ton roller is better than none at all. I am rather surprised to know that a town like Leek does not possess a steam roller. I think the Council would be well advised, on economical grounds, to purchase one. Mr. Beacham says a street laid with tar macadam, at the end of five years was very badly damaged, which shows that tar macadam is not a success with heavy traffic. My experience is that if tar macadam will last five years under heavy traffic, it is not altogether a failure. I should like Mr. Beacham to tell us how he mixes it; whether he uses crude or refined tar or some proprietary article; and whether he considers limestone is preferable to granite for the purpose. Mr. Beacham compares the cost of artificial flags with Lancashire sawn flags, and he states that he uses the Lancashire flags. Seeing that the artificial flags are so much cheaper than the Lancashire flags, I should like to know the reason for that. Mr. Beacham says they are treated with every consideration by the County Council; that is rather refreshing; we do not all hold the same opinion. I notice that the making up of streets previous to adoption is done by administration. Personally, I always do that work by contract. Generally speaking, it is more satisfactory to the owners of property; they are not so liable to complain that the work is too costly when it is tendered for in competition. Mr. Beacham is certainly to be congratulated on the Globe Yard improvement, that improvement was effected at the cost of the street making only. I think that is a feather in his cap. With reference to street improvements generally, I should like to know whether he succeeded in obtaining any money from the Road Board. We have all been trying to get money, but have not got much at present. Then Mr. Beacham says trade refuse is removed without charge. So far as I know this is a somewhat unusual course. I should like to know if there is any special reason for that. Perhaps he requires all the material he can get for the bacteria beds. The remarks as to the filters filled with town refuse are very interesting. It is the first time I have heard of anything of the kind. As might be expected, from the analysis, the nitrates are not very high. I should also like to know whether he experiences any nuisance from the septic tanks. I have not had a great experience of

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these, but what I have has been very unfortunate. They have seemed to poison everybody in the neighbourhood. I should like to know how often the septic tanks are emptied. Mr. Beacham does not appear to experience the same difficulty in getting rid of his sludge as most of us do. I think the outstanding feature of this very interesting paper is the price at which the water is sold. It seems to me a remarkably successful undertaking, and I think the Chairman of the Council is very modest when he says that it is cheaper than most water supplies. It is cheaper than any I know of. With reference to the fire engine I should like to ask if the Council have any difficulty in horsing the fire engines, either the manuals or the steam engine. In some of the smaller towns it is a very serious problem. You have to subsidise the local people, otherwise they refuse to keep the horses at your disposal. I should like to know whether there is any difficulty here. I do not quite see the object of these water tanks in various parts of the town. I gather you have ample pressure; I should have thought that the pressure from the mains was sufficient for any fire. I notice the town is particularly hilly, and perhaps the pressure is not sufficient in the highest parts. With reference to the scheme for the baths, the general arrangement seems very good; but I should think the Council would be better advised to go in for a new suite of baths, rather than remodel the old baths. In my town the baths are much larger than Leek, but we are faced with the problem of providing new baths, as the accommodation is not sufficient. There is little to criticise in the scheme, except perhaps the steps from the gallery of the first-class bath in the new suite, which comes rather awkwardly in relation to the exit from the ground floor. Assuming that it is not possible for the public in case of panic or fire, to get on to the hospital grounds, I think it is probable there would be some delay in getting them away from the building. The gallery steps in the baths, as remodelled, rather obstructed the exit from the first-class swimming bath on the ground floor. At the foot of the stairs where the people from the gallery and the ground floor would converge in the case of a panic, there would be considerable danger of some of them being pushed into the bath.

Mr. W. B. Madin: I have much pleasure in seconding the vote of thanks to Mr. Beacham for his very able paper. It has

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been very interesting to me to come here. I was for several years assistant to Mr. Beacham's predecessor, and know many of the public works referred to. Dealing with the paper, the death rate seems rather high for a country town, 16·6 per thousand. With a healthy situation like this, I should have thought it would have been less. I agree with Mr. Plant's remarks *re* roller, I think a 6-ton roller is to be preferred to a 10 ton for tar macadam. Mr. Beacham says he has made 1¼ mile of tar macadam at a cost of 2*s.* 6*d.* per yard. I should like to ask how thick it was, and the material it was made of. I quite agree with Mr. Beacham as to the making up of private streets. I think it is better for the Council to complete the work, after building is finished, instead of having the streets made up and completed beforehand. There is one point which particularly struck me, and that is the valuable aid that the town land trustees have given to the Council. They have given valuable financial assistance, such as I should think very few towns have had. With regard to the sewage filter filled with town refuse, that is very interesting, if the results are borne out by analysis.

MR. BEACHAM: The analysis is of the "tip" only.

MR. MADIN: Then it is very satisfactory. With regard to the cost of keeping horses, the price of 16*s.* 9*d.* seems rather a heavy item. Coming to the question of water supply, Leek is exceedingly fortunate in having a supply of water so cheap and wholesome. There is no doubt, in this particular, as, indeed, in most of the public works of Leek, the present local authority are greatly indebted to the people who went before them—the Leek Improvement Commissioners—in purchasing the works, rather than letting them stay in private hands. Then, with regard to the public baths, I notice Mr. Beacham shows alternative plans—one for remodelling the present baths, and one for new baths, on a new site. I am sure the Council will be well advised to go for the latter scheme. If I might make a suggestion, I should make the swimming bath longer than 75 feet. The question whether it is desirable to have two swimming baths is more a matter for the Council than for us. I see the shortage of houses is going to be made good by private enterprise. There is a good deal to be said for that. It creates a good deal of friction sometimes when the Council erect houses. At the same time, some municipal houses I have seen have been

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an excellent copy for the private speculator. They have been so exceedingly well carried out.

MR. J. LOBLEY: It has been a pleasure and surprise to me to notice the amount of work which has been carried out in Leek during the past ten years. It reflects a great deal of credit upon the local authority and upon the surveyor. I notice Mr. Beacham, speaking of private streets, says the minimum width of the footpaths is 6 feet, and the carriageways 24 feet. Some forty years ago I induced my Council at Hanley to adopt a ratio of one-fifth of the entire width of street, instead of one-sixth for footpaths, and you will be surprised to compare a street, 36 feet wide, with footpaths of 7 feet instead of 6 feet. The result is a greatly improved appearance. I was successful in getting that proportion laid down in the new by-laws passed by the Local Government Board for Hanley, and those by-laws have now been extended by the Federation Act of Parliament for the entire borough of Stoke-on-Trent. Speaking of street widening, I notice that some of the streets have been widened up to 36 feet. The growth of public opinion has been so great that it was easy for me to get streets widened 55 feet or 60 feet during the last ten or twenty years, as it was to get 36 feet in the first ten years I was at Hanley. After all, when you are widening a street and buying property, the cost of doubling the increased width is by no means also doubled. My Council at Hanley sanctioned improvement lines for over 9 miles of main roads, making them 55 feet and 60 feet in width. Much of this has been carried out, and the present Federated Council, of what Mr. Arnold Bennett calls the five towns, but what is really six towns, is continuing this policy for the entire county borough of Stoke-on-Trent.

MR. E. J. GOODACRE: Leek seems especially fortunate in regard to its water supply. I should like to know if they are also specially fortunate in regard to the dust nuisance, because I find no reference to dust, although they have over 8 miles of granite macadam in the town. They seem to have plenty of tar available at their own works, and I should like to know if they do any tar-spraying, and, if so, the cost of the same. Then there is a point with regard to the use of Lancashire stone slabs in preference to artificial flags, which are much cheaper. I think, in comparison, as regards strength and wearing properties, the artificial flag would stand very well against the Lancashire flag. With regard to the use of house refuse as a medium

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for sewage filtration. I should like to ask whether the refuse is first riddled and the vegetable matter taken out. It is usual when house refuse becomes wet for it to become a nuisance. I should also like to know in what condition the sewage is taken to the hovel filter; also the character of the crude sewage. I have not found any mention as to whether it is very bad. There is one other point, with regard to the public baths. I should hardly have thought it necessary to put in a filtration plant when town water is cheap and plentiful. Perhaps Mr. Beacham has some special reason for this. With regard to the provision and use of water tanks for fire prevention purposes a little more information on that point would be useful.

Mr. F. C. Cook: I note that the Local Government Board are asked to give the Council power to vary the width of carriageways and footpaths in new streets, but I take it to be the intention of the Council to aim at the total width of the whole street being 36 feet. While the Council are at it I would suggest a minimum of 40 feet, for it is very much easier to obtain the land before a street is laid out than after houses are built upon it. Then the result of the analysis Mr. Beacham gives of the effluent from that very interesting filter of house refuse seems to be an old one. He says the analysis was taken by Mr. Carter Bell some years ago. I should like to know if he has had any analysis taken lately, and whether we could have the result, so that we may ascertain whether there is any deterioration in the quality of the effluent. Then Mr. Beacham seems to have omitted to give us the dry-weather flow of the sewage. I see he has adopted the system, which seems almost peculiar to Staffordshire, of having an exceedingly fine medium in his percolating filter, the top foot being of $\frac{1}{4}$ inch to $\frac{1}{8}$ inch material. I would like to know whether he has found any ponding of the surface, and what method he has for washing the media from time to time. It seems to me it must get choked up very badly. Mr. Beacham claims to treat 120 gallons per square yard per 24 hours. The filters have only worked 4380 hours during the year, which is just half the time they might have worked, so instead of 120 gallons it surely ought to be 60 gallons. It is a common mistake to give the capacity of a filter at such a figure per square yard, as it does not represent the quantity treated all through the year, and this is very misleading. I have been very much interested in the description of

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the sludge filters. I understand Mr. Beacham puts his sludge on to a depth of 2 feet. If so, I should like to ask how long he gives it to dry, and what condition it is in when ready for removal. It seems to me that sludge at that depth, unless peculiar in character, would be almost impossible to get out and load into carts. Will he also tell us the price paid per load of sludge removed by the farmers, if he is fortunate enough to get money for it. I should also like to know the proportion of dye-water in the sewage, and if he can decolorise the effluent before putting it in the stream. It is stated that the circular distributors have been working continuously for several years without giving any trouble. It would be very interesting to have the comparative expense of the different types of filter after they have been working for several years. We have so many types of distributors now at work, I should like to see some reliable figures as to their relative maintenance cost. Leek is to be congratulated upon its water supply. The supply main is only 8 inches in diameter, which is very small. Perhaps Mr. Beacham can tell us the normal pressure in the town. Mr. Beacham does not give us the financial results of the baths. They seem to be very popular here, for a comparatively small town, such as Leek, to be now contemplating the provision of additional baths. In regard to the housing scheme, I think the Council are to be congratulated if the housing question can be settled by private enterprise. To my mind, it is absolutely the right thing to do, and I hope they will be successful in that respect.

MR. J. H. WALTERS: With regard to the cost of keeping the horses, I should like to ask whether Mr. Beacham has any method of measuring the corn and hay given to the horses, or if he includes the prices of the horses and depreciation. It seems a very high price.

MR. G. MASON, Chairman of the Council: I should like to congratulate Mr. Beacham upon his work for the town and upon this paper, descriptive of our public works. The paper has not suffered by criticism. The Council value Mr. Beacham's services to the town very highly.

THE PRESIDENT: Before putting the vote of thanks to Mr. Beacham I should like to repeat, what I said earlier, how very much we are indebted to him for so excellent a paper giving so much detail. It will be of value, not only to the younger

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Members of the Institution, but to all who are engaged in work similar to that described. The discussion has not been at all antagonistic to the paper, far from it; it has been mostly confined to questions, asking for further information, and, in reply to those, no doubt Mr. Beacham will satisfy us. Some remarks have been made as to the use of a 10-ton roller on tar macadam. I am inclined to think a 10-ton roller is too heavy for tar macadam, because I have found that a so-called 10-ton roller weighs nearer 12 tons when at work. I have found that in putting down tar macadam the "creeping" which takes place in the coating can be prevented by tar-painting the road surface first. I quite agree that Mr. Beacham need not be alarmed when he finds that tar macadam wears out in five years. It is very largely a question of traffic and of gradients. Mr. Beacham need not lose heart in that respect. Reference has been made to the exits from the bath in case of fire; but if, as one of the Members remarked, they might probably get into the water they would not get burnt. I congratulate Leek on keeping all municipal enterprises in their own hands, as they can do the work to their own satisfaction. I agree with Mr. Cook as to housing, if it can be accomplished by private enterprise it is obviously the right thing to do. Those who own the land should have a hand in the improvements, and the responsibility should not be placed upon the public purse. From the plans and descriptions given Leek has been quite prominent in widening its streets and the making of public improvements, and I hope other small towns will follow the example. This week I had the pleasure of forming one of a deputation to Mr. Asquith, at the House of Commons, asking him to formulate a scheme whereby all the local authorities should be assisted by a central authority to co-ordinate their schemes of town planning and provision of arterial roads. Mr. Asquith expressed his sympathy, and promised that the matter should not be lost sight of, and it was suggested that the Councils of Greater London might meet together and discuss town planning schemes with reference to arterial roads, which is an important matter, and Mr. John Burns promised to meet the Councils of Greater London and discuss with them whether it was not possible to formulate some scheme by which those Councils should work together in the matter of arterial roads out of London. That is important, as far as it goes. If that produces beneficial results in London it will also be applicable

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to the smaller towns in the country. If we can agree upon some method for the various authorities working together and symmetrically, we should accomplish something for the future.

The vote of thanks having been accorded,

MR. W. E. BEACHAM, in reply: I am much obliged to you for the vote of thanks for the paper, and the gentle way in which you have dealt with me in the discussion. I will take first Mr. Plant's remarks as to granite tarred macadam, the particular street which has not to my mind worn satisfactorily was made with Welsh granite treated with refined tar in my own yard. The street is subject to hard traffic, and the Council were anxious to see what it would do. I was very disappointed, because I should have thought that granite would have worn much longer than ordinary limestone. You will see the street and will be able to form an opinion as to whether granite is better than limestone tar macadam.

THE PRESIDENT: What character was the heavy traffic—motor or traction engines?

MR. BEACHAM: It is horse-drawn traffic. Heavy lorries carrying corn, about two tons in weight. With regard to artificial flagging as compared with Lancashire stone flags, I do not compare the two in life. Most of the streets of Leek are on gradients, and I am not sure that artificial flagging is the best on gradients. Personally, my opinion is that the Lancashire flag is better than the artificial. It gives a better footing. As to private street works being executed by contractors. We have no street contractors in Leek who undertake private street work, and besides, the house owners prefer the town surveyor to do the work if we are going to take the street over. They are satisfied that the cost is reasonable. We think it is better from the Council point of view, and the owner point of view also, for it to be done in this way. Some of our improvements were carried out prior to the Road Board being constituted. We have not so far tried them for a grant for street improvements in the town, but we have tried them for main road improvements, but with no success at present. With reference to the removal of trade refuse, the Council point of view is that the sooner any refuse is removed from the premises the better. It may be a little costly, and perhaps the tradespeople should pay, but we have not approached them as to a charge up to the present. As to nuisance from the septic tanks, we do occasionally get complaints, from the

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sewage farm generally, but you cannot have sewage works anywhere and be quite free from smell. There is very little smell from our sewage works. I have cleaned out the septic tanks three times in 6½ years, and found there was 1 foot 9 inches of sludge at the deep end, and about three inches at the shallow end. We have no great difficulty in getting horses for the fire engine. Our fire station is close to the livery stables; we are on the telephone, and have experienced no inconvenience in getting horses in case of emergency. With reference to the fire tanks, the suction main of the steamer is 6 inches, and our water mains are 3 inches generally. There was difficulty in supplying the steamer with sufficient water. The Council decided to put down these tanks, coupled with a 6-inch main, which are only used in case of fire. The tanks are so located that with the length of hose we have, we can reach all the big mills. With regard to the death rate we consider that Leek is a rather bleak place, and think if we can keep our death rate at fifteen or sixteen per thousand, we are doing well. Then the nature of the industry is against a low infantile death rate. Most of the workpeople in the silk mills are women and girls, and the children cannot get the attention they would have if the women were at home. Our streets were made of local stone. We strip them to the pitching, and put on 5 inches of tar macadam rolled. As to horse-keep the cost does look excessive; but I will give you the figures for provender comparable with what they were in 1909. In 1909, with oats at 24*s.* 5*d.* per quarter, and bran at 18*s.* 9*d.* per quarter, the cost was 11*s.* 10*d.* per horse per week. The food to-day, allowing the same quantity per horse, costs us exactly 16*s.* 8*d.* We pay for hay, although we are up against the agricultural districts, 6*l.* 17*s.* 6*d.* per ton, whereas in 1909 we were paying 4*l.* 5*s.* Mr. Maden raised the point of having two swimming baths. The Committee's idea is that the day is coming when the teaching of swimming will be a question for the elementary schools, and I believe the County Authorities are disposed to help local authorities where they do teach swimming. I felt, in designing baths, that if you want to encourage first-class swimmers, you really want somewhere for the school children. It is suggested that the second-class bath in connection with the new baths would be used for the teaching of swimming to the school children, leaving the first-class bath for adult swimming. I have said nothing as to tar spraying, but up

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to the writing of this paper we had done none in Leek. Since the paper has been written we have done half a dozen streets, and we find the cost works out, using refined tar and granite chippings at 1·16*d.* per square yard. The price of tar has recently gone up from $3\frac{3}{4}$*d.* to $4\frac{3}{8}$*d.* per gallon, and the cost is now 1·3*d.* per square yard. We have laid two streets with tarvia on the Field's estate or Globe Yard. It is laid with Clee Hill granite grouted with tarvia. We get no nuisance from the refuse tip, because we cover up the refuse as soon as we possibly can with the soil we take off before we begin to deposit refuse. First we strip the present soil off the top for a foot or 18 inches, put on the refuse, and then cover it with the soil, leaving as little face exposed as possible. The crude sewage of Leek is supposed to be four times stronger than Hanley. That may be accounted for by the fact that in Hanley they get such a quantity of slip water. We get a lot of dye water. I am not able to give you the exact quantity of dye water, but I might put it in this way, we sell to the manufacturers for manufacturing purposes 38,000,000 gallons per annum, and that water we have to deal with at the farm. As to the filtration of bath water, we have to clean the bath in mid-week as well as week ends. On Wednesday night we empty the bath, clean it, refill and heat the water for Thursday morning, and unless you have ample boiler capacity, that cannot be done until mid-day. It was felt that by filtration we should constantly keep the water changed, suit the convenience of the swimmers and economise water. Because we have an ample water supply, there is no reason why we should not husband it. It is an economy to have a filtration plant for the reasons I have given. As to the analysis of the effluent from the tip filter, I admit it is an old one; but the County Council send regularly to test our effluent, and we are satisfied if we receive no complaints. The dry-weather flow is 200,000 gallons. With regard to the filters, I have made it quite clear, I hope, that they have to be rested. They are not what I understand to be continuous filters. I do not think any fine-grade filters are continuous. Our filters work a fortnight straight ahead; they are then rested for a fortnight, and the surface is lightly forked over to allow them to aerate. While they are working they are dealing with 120 gallons per square yard per day. We get no ponding on the surface. We know the exact quantity the filters will deal with. I think it is extremely

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difficult to lay down a standard for any particular kind of filter. It depends entirely upon the quality of the sewage going on. We find just the quantity they will take, and how long they will run before they want a rest, and we keep to that. We are sending into the river such an effluent that no exception is taken to it by the County Council. We have two roughing tanks which we empty twice a week. We have no trouble with our sludge.

Mr. J. H. Walters: Does one farmer take the whole of it?

Mr. Beacham: Yes. The effluent is highly discoloured on coming out of the septic tank, but leaving the filters it is quite clear. The pressure of water at the lower part of the town is 110 lbs. per square inch, and at the top of the town 20 lbs. to 25 lbs. The baths are not a paying concern, but we do not look at them from the financial point of view entirely. If we could build the baths and run them at the same loss as now, the Council would be satisfied.

The President: There is a duty I have to perform, that is to propose a vote of thanks to the Council for the use of the Town Hall for our meeting.

The vote of thanks was unanimously accorded.

The Members had luncheon together at the Swan Hotel, Mr. R. J. Thomas presiding.

The afternoon was devoted to visits to the public baths, butter and poultry markets, Nicholson Institute, public library, technical schools gymnasium, the fire station, Globe Yard improvement, Belle Vue Road, electricity, gas, and sewage disposal works.

The Chairman of the Council entertained the Members to tea.

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VISIT TO AMSTERDAM AND THE HAGUE.

May 9–13, 1913.

ON Friday, the 9th of May, the Members assembled at the Town Hall, Amsterdam, where they were received and welcomed by the Burgomaster, Baron Roell, who was accompanied by the acting Burgomaster, Mr. Delpratt, and a number of the city officials, who extended a warm welcome on behalf of the Council, and hoped that the visit would prove both instructive and agreeable.

The President returned thanks on behalf of the Institution for the hearty welcome afforded to the visitors. He referred to the friendly relations existing between the peoples of Great Britain and Holland, and paid a high tribute to the great skill which had been shown by Dutch engineers in their long struggle with the sea.

At the Exchange, Mr. Bos, the Director of Public Works, together with Messrs. F. S. Jacob and P. Lohr, the city engineers, Mr. W. A. de Graaf, and Mr. D. Drost, gave the following details, descriptive of the problems with which Amsterdam is confronted.

AMSTERDAM AND ITS DRAINAGE WORKS.

It may not be generally known that the canals for which the city of Amsterdam is famed are now the source of the very greatest anxiety to the authorities of the city, the once pure water being at the present time in a condition which is perhaps best described as deplorable. As long as the bay, known as the Y, was in open communication with the Zuider Zee, the daily influx of tidal water sufficed to maintain a tolerable state of cleanliness of the canals; but when, in 1872, this open communication was cut off, artificial means became necessary to get rid of the polluted water and to introduce pure water in its place. This question became of greater importance when a new town began to arise outside the old boundaries of the city.

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The renewal of the water in the canals is effected by means of eight huge paddle-wheels, which carry in sea water through nine syphons under the Merwede Canal. During the night the canals are shut off from the North Sea Canal and the Y by locking several floodgates, and early in the morning the swollen canals discharge into the Y, which discharges its water into the sea at low tide. The arrangement of the paddle-wheels is such as to allow water to be pumped in a contrary direction from the canals into the Zuider Zee.

As early as 1870 a new sewage system was planned for the old town. The works included the filling in of some 600 miles of canal, by which the picturesque aspect of the town would have badly suffered, and as the cost was naturally very great the scheme was shelved. In later years, however, the street traffic increased so enormously that the filling in of 200 miles of canal could not be avoided.

The fact that, when the revival of Amsterdam began, a new complete sewage system was not planned, is explained as follows: The so very rapid growth of the town was not foreseen, a great part of the ground occupied by the new sites did not belong to Amsterdam, but to suburbs; the cost of the works was prohibitive, taking into consideration the state of the finances in those days, while there was also a great difference of opinion as to the real cause of the unsatisfactory state of the canals. This was attributed by some to the fæces brought into the canal from the surrounding premises, but others, again, were of opinion that the main sources of pollution were sewage water and town refuse. After serious consideration by the municipal council a pneumatic system for the removal of fæces was adopted, the main feature of this system being that the fæces were drawn from the premises by means of a vacuum, thus avoiding the necessity of making sewers of large sectional area and steep gradients.

Captain Liernur's System.

It would appear that while from a technical point of view the system has been a success, from an economical one it has proved to be a failure. As a result of the introduction of water-closets the fæces got mixed with such a quantity of water that it was impracticable to transform them into manure. As a last attempt to employ them profitably, the diluted fæces were treated with lime, so as to bind the ammonia, which, when heated, was

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brought into contact with sulphuric acid, a good manure thus being obtained. Though by this process considerable sums of money found their way into the city treasury, the working expenses of the system proved to be prohibitive, for even by this process by far the greater part of the fæces had to be thrown into the canal adjoining the works, causing pollution over a long distance. This system having proved a failure, no further extensions were embarked upon, all new premises being connected to underground reservoirs which, at regular periods, were emptied pneumatically into tank waggons.

In 1907 the city engineer at last gained his cause by the granting by the city council of a sum of 250,000*l.* for the making of a proper sewage system, worked by a system of powerful pumps. Physical and financial reasons made it impossible to construct sewers of such dimensions as would carry off the whole volume of rainfall during periods of storm.

Since the main sewer runs round the inner city, following one of the canals, it was possible without difficulty to choose a number of points at selected places along the canal banks where sewage could be discharged to the greatest advantage. The branch sewers have a sufficient capacity to allow of their conveying the storm water to these outlets in spite of the flatness of the gradient. The sluggish flow may, of course, lead to deposits of road grit, sludge, and other solid materials; on the other hand, the velocity of the dry-weather flow, which will attain a minimum rate of 1¼ miles per hour, is expected to remove these deposits and even to prevent them. Moreover, the sewer system, being constructed, even at the beginning of its course, at a considerable depth below canal level, may be flushed by canal water.

The sewage would flow until a depth of 15 feet below the street surface is reached. Here the new electric pumping station will lift the sewage, and pass it on to the chief pumping station which will be able to deal with about three hundred and eighty gallons per second. The quantity of sewage to be dealt with precludes all ideas of building collecting basins. It was decided, therefore, to provide only large settling basins or grit chambers. As no other purification treatment will be applied to the sewage, these chambers are provided with removable screens, which protect the pumps by keeping all floating substances effectually away. It being desired to place the pumps below the dry-

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weather flow level of the main sewer, the basins have a considerable depth. Each pump is placed separately in a chamber.

The substructure of the station and basins is in reinforced concrete. As regards extension of the capacity of the station, the Members were given to understand this could be undertaken without any difficulty. The plan of the building is in keeping with the simplicity of the mechanical arrangements. The architectural details give it a simple but tasteful outward appearance, making it quite an ornament to the new quarter of the town, which begins here. The construction of the works has been in operation since 1908.

In addition to this a project is now in a far-advanced state of preparation for the destruction of town refuse, and a sum of nearly 67,000*l.* has been granted for the connection with the new sewers of those premises which are at present dependent on the existing system. These sewers are placed horizontally at the level of the water in the canals and in the North Sea Canal, that is 1 foot 6 inches under the level known all over Holland and in the greater part of North Germany as Amsterdam level. The main sewer, now in course of construction, follows the direction of the old town boundary, and by means of powerful electric pumps, situated at the east end of the town, its contents are forced through a conduit of reinforced concrete over a length of 3 miles into the Zuider Zee.

The Outfall Works.

Reinforced concrete was chosen as the material of the tube, which has a circular section with an inner diameter of 60 inches, the sides having a thickness of 4 inches.

From the pumping station the tube mainly follows an old sea dyke, called the Zeeburgerdyk, passes with a syphon under the Merwede Canal, and then runs along a dam in the sea to the point of discharge. This last dam had originally been constructed to preserve a navigable channel in the Zuider Zee, and advantage was taken of the dam to lay the tube along it.

Although the ordinary movement of the water and the usual difference between high and low tide at the end of the tube are not very considerable, it is believed that so far out at sea the sewage can be discharged without further purification.

To counteract any harmful effect of the sea water upon the concrete, slowly hardening Portland cement and some trass were

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used in the strong mortar, while the separate pieces which form the tube were not allowed to come into contact with the salt water until they were at least one month old.

These separate tube pieces are about 10 feet long; between them an opening of 2 inches is left, while round this joint a ring of reinforced concrete, 20 inches wide and 4 inches thick, has been laid. The joint, as well as the space between the tube and the ring, were filled up with Portland cement mortar. In the dam, however, one of every eight joints was filled by a mixture of asphalt and bitumen, in order to allow of the tube following the setting of the subsoil, and of expansion or shrinkage by changes in temperature.

The experience with these asphalt joints has not been entirely favourable, as the asphalt began to melt during warm summer weather, and, because it did not expand as the tube shrank, caused cracks and leaks in the pipe. After the tube had been down sufficiently long to warrant the expectation that the subsoil had finally settled, the asphalt joints were cut out and replaced by cement mortar.

The armouring of the tube is a double network of round iron, $\frac{3}{8}$ inch thick for the principal armouring, and $\frac{5}{16}$ inch for the secondary armouring.

The tube is ventilated by ten automatically working air valves placed at the highest points, while for purposes of inspection a cover has been put about every one hundred and ten yards.

The testing of the whole tube under pressure has not yet taken place, so that a final judgment as to the tightness of the joints cannot yet be formed.

At the outflow the pipe's end is provided with a gate to make the closing of the tube possible. From this gate the sewage is carried between two dams of reinforced concrete, resting on a substructure of piles about forty yards out to sea. The total length of the tube is about three and a half miles, and about eight hundred and ten miles of iron, weighing about six hundred and sixty tons, have been used for the armouring. The total cost of the work was about 35,000*l.*

THE PUMPING STATION.

At the main pumping station three pumps have been installed up to the present, two of these having a capacity of 134 gallons

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per second each, and the third a capacity of 268 gallons per second. The last-mentioned pump is therefore twice as powerful as each of the smaller pumps. The capacities are figured on a maximum head of about thirty-nine feet of water, which is necessary to force the sewage through the concrete pressure tube and against the highest registered Zuider Zee tide. The number of revolutions of the smaller pumps is 485, and that of the larger pump 360 per minute, both numbers being constant on account of the use of alternating current motors. The capacity of the large motor is 300 horse-power, and that of each of the smaller motors 150 horse-power. The normal discharge of this pumping station will be about four hundred gallons per second, and will be effected by the large pump and one of the smaller pumps when working together. The cost of the complete mechanical and electrical equipment of this pumping station amounts to about 6000*l.*

AMSTERDAM'S NEW GASWORKS.

The area of the new "Zuider" gasworks which the Corporation of Amsterdam are erecting is no less than 30 acres, and 52 acres of ground are available for extensions if they become necessary in the future. The principal building is the retort house, 308 feet long, 88 feet wide and 93 feet high, with six benches of five furnaces, each with eighteen vertical retorts. The maximum daily output will be 6,360,000 cubic feet.

The Members proceeded to visit the sewage pumping station and outfall works in course of construction, the old sewage works of the town, and the extensive tramway depôt. On Saturday, the 10*th, the Members visited the new "Zuider" gasworks, an installation which, when completed, will be up to date in every respect.*

On Tuesday, the 13*th, a visit was paid to The Hague, where the Members were received and welcomed by Mr. Lindo, the Director of Public Works, and the party was conducted over the new Abattoirs. These splendidly equipped buildings were thoroughly inspected and greatly appreciated. A visit to the "House in the Wood," and a drive to the famous North Sea resort, Scheveningen, followed in the afternoon.*

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FORTIETH ANNUAL MEETING.

Great Yarmouth, July 16–19, 1913.

MR. R. J. THOMAS, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Members assembled in the Town Hall, Great Yarmouth, where they were received and welcomed by the Mayor, Mr. Councillor Reginald G. Westmacott. He hoped they would take away with them memories of a very pleasant and instructive time.

The President thanked the Mayor for his kind words of welcome.

The Secretary read the minutes of the last Annual Meeting, which were confirmed and signed.

The President moved the adoption of the Council's Annual Report, this was seconded by Mr. T. W. A. Hayward, and after discussion, the Report was adopted *nem. con.*

Messrs. Wood, Drew & Co., were unanimously elected Auditors for the ensuing year.

Messrs. R. J. Angel, N. H. Dawson, F. Harris, T. Henry, P. G. Killick, W. F. Loveday, A. E. Prescott, W. B. Purser, and J. A. Webb were unanimously elected Scrutineers for the ensuing year.

The President then presented the Institution's Premiums for papers read during the previous year, awarded by the Council as follows:—5*l.* 5*s.* in books to Mr. E. R. Matthews for his paper on "Sea Defence Works" read at the Bridlington meeting, and 3*l.* 3*s.* in books to Mr. H. W. Barker for his paper on "Cemeteries" read at West Bromwich.

The President then introduced his successor, Mr. J. W. Cockrill, and vacated the chair in his favour.

A hearty vote of thanks to the retiring President for his

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able management of the affairs of the Institution during the past year, was proposed by Mr. J. S. Brodie, seconded by Mr. G. W. Lacey, and carried with acclamation.

ANNUAL REPORT.

THE Council have pleasure in presenting the 40th Annual Report, recording the work of the year 1912–1913.

NEW CONSTITUTION.

The alterations in the constitution made at the Annual General Meeting in 1911 have proved of great benefit to the Institution, and are now working perfectly smoothly.

The re-arrangement of the Districts has been found satisfactory, and the closer touch with the Members generally through their district officers has been of great utility to the Council. The enhanced scope of the work of the Institution, and the advantages gained by membership, were brought to the notice of engineers and surveyors to local authorities generally, by a circular letter issued by the Secretary in November last. The gratifying nature of the response is shown in the large increase in membership recorded in "The Roll of the Institution," but the Council trust that Members will continue their efforts to induce properly qualified officers to apply for membership, and will bring the advantages to be gained by being attached to the Institution at as early an age as possible, before the younger members of their staffs.

THE NEW COUNCIL.

The Scrutineers, having examined the ballot lists, report the following Members elected as the Council for the year 1913–1914:

President.—J. W. Cockrill.

Vice-Presidents.—T. W. A. Hayward, J. S. Pickering, and H. T. Wakelam.

Ordinary Members of Council.—J. Patten Barber, W. Nisbet Blair, John A. Brodie, J. S. Brodie, G. F. Carter,

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A. E. Collins, W. Harpur, W. T. Lancashire, H. E. Stilgoe, and C. F. Wike.

Honorary Secretary.—Chas. Jones.

Honorary Treasurer.—Sir James Lemon.

Serving upon the Council, in addition to the above, are the District Vice-Presidents and the District Representatives reported by the Scrutineers as having been elected for the year 1913–1914:—

DISTRICT OFFICERS.

Vice-President for Scotland.—J. Bryce, Partick.

Vice-President for Ireland.—H. A. Cutler, Belfast.

District.	Chairman.	Representative.	Secretary.
Scottish.	F. G. Holmes (Govan).	A. H. Campbell (Edinburgh).	D. Ronald (Falkirk).
Irish.	W. Collen (Dublin Co.).	R. H. Dorman (Armagh Co.).	M. Sellars (Dundalk).
North-Eastern.	F. Massie (Wakefield).	E. B. Martin (Rotherham). E. R. Matthews Bridlington).	J. P. Wakeford (Wakefield).
North-Western.	J. S. Brodie (Blackpool).	C. Brownridge (Birkenhead). W. Stubbs (Blackburn).	A. W. Bradley (St. Helen's).
Eastern.	H. T. Wakelam (Middlesex Co.).	E. J. Elford (Southend). W. H. Prescott (Tottenham).	J. A. Webb (Hendon).
Metropolitan.	J. P. Barber (Islington).	N. Scorgie (Hackney). O. E. Winter (Hampstead).	N. Scorgie (Hackney).
South-Western.	H. T. Chapman (Somerset Co.).	T. Moulding (Exeter).	D. Edwards (Taunton).
West Midland.	A. T. Davis (Salop Co.).	A. T. Davis (Salop Co.).	F. C. Cook (Nuneaton).
Southern.	R. Read (Gloucester).	L. S. McKenzie (Bristol).	F. R. Phipps (Basingstoke).
East Midland.	E. G. Mawbey (Leicester).	E. P. Hooley (Notts Co.).	H. G. Whyatt (Gt. Grimsby).

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District.	Chairman.	Representative.	Secretary.
South-Eastern.	A. Dryland (Surrey Co.).	P. H. Palmer (Hastings).	H. W. Bowen (Sussex Co.).
North Wales.	J. Price Evans (Wrexham).	E. Evans (Carnarvon Co.).	J. England (Wrexham).
South Wales.	W. Harpur (Cardiff).	G. A. Phillips (Glam. Co.).	H. Alex. Clarke (Briton Ferry.)

PUPILAGE.

Requests for advice as to pupilage having been frequently received, the Council invited Members who are willing to take pupils to communicate with the Secretary, setting forth the period of Articles, amount of premium required, and works in hand.

A large number of replies were received and tabulated, and valuable assistance has been accorded to some thirty applicants for advice.

AFFILIATION OF THE COUNTY SURVEYORS' ASSOCIATION OF IRELAND.

The Council are gratified to record the completion of the affiliation of the County Surveyors of Ireland Association with this Institution, resulting in an accession of nineteen Members.

AFFILIATION OF THE LOCAL GOVERNMENT ENGINEERS' ASSOCIATION OF NEW ZEALAND.

The Council are also gratified to report that negotiations are proceeding with a view to the affiliation of the above Association with this Institution.

ABBREVIATION OF TITLE.

The Council draw attention to By-law 22.

"The following, and no other, abbreviations may be used to denote connection with the Institution :—

Hon. Mem. Inst. M. & Cy.E.	A.M. Inst. M. & Cy.E.
M. Inst. M. & Cy.E.	Stud. Inst. M. & Cy.E.

As this by-law forms an agreement entered into by the Council on behalf of the Institution, the Council trust that Members will assist them by using the exact form of abbreviation as shown."

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Meetings of the Institution.

Meetings of the Institution have been held in the :—

Eastern District at Grays, September 21, 1912.
East Midland District at Ilkeston, September 28, 1912.
North Wales District at Wrexham, October 19, 1912.
Metropolitan District at Westminster, December 6, 1912.
South Wales District at Swansea, January 11, 1913.
Eastern District at Gerrards Cross, April 26, 1913.
North-Eastern District at Newcastle-on-Tyne, May 2 and 3, 1913.
Scottish District at Dundee, June 6 and 7, 1913.
North-Western District at Rochdale, June 14, 1913.
West Midland District at Leek, July 5, 1913.
And at Amsterdam, May 8 to 14, 1913.

District Meetings.

These will be found under the heading of "District Secretaries' Reports."

The Roll of the Institution.

During the financial year ending April 30 last, 269 new Members, consisting of 145 Ordinary Members, 62 Associate Members, 41 Students, and 21 Affiliated Members, have been elected. Thirteen Members, 6 Associate Members, and one Affiliated Member have resigned.

Ten Members and 3 Associate Members have been written off.

The Council record with regret the deaths of :—T. T. Allen, J. T. Eayrs (Past President), J. A. Hoyle, P. J. Lynam, J. G. O'Sullivan, W. J. Press, J. Proctor, F. W. Richardson, W. P. Robinson, W. T. Shell, Jas. Smith, and W. Weaver (Past President), also of J. Robb (Affiliated Member).

The roll now stands :—

—	1906 to 1907.	1907 to 1908.	1908 to 1909.	1909 to 1910.	1910 to 1911.	1911 to 1912.	1912 to 1913.
Hon. Members	9	9	8	8	8	13	13
Members	850	834	818	830	839	1028	1153
Associate Members	—	39	78	114	128	243	290
Associates	144	123	127	137	131	—	—
Graduates	204	204	170	160	151	—	—
Students	—	—	—	—	—	29	69
Affiliated Members	—	—	—	—	—	47	58
Total	1207	1209	1201	1249	1257	1360	1583

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Six Associate Members, 8 Affiliated Members, and one Student have been transferred to the class of Member.

Visit to Amsterdam and the Hague.

At Whitsuntide a visit was paid to Amsterdam and the Hague.

The Members were received and welcomed at Amsterdam in the Town Hall by the Burgomaster, Baron Roell, the Acting Burgomaster, Mr. Delpratt, and a number of the city officials, the party being introduced by Mr. W. A. Churchill, the British Consul.

At the Exchange, Mr. A. W. Bos, the Director of Public Works of the City, together with Messrs. F. S. Jacob and P. Lohr, the city engineers, gave detailed descriptions of the engineering works of the city, several of which were afterwards visited, including the sewage outfall, the pumping works, and the tramway garage, in course of construction. The new gas works, an installation which, when completed, will be up to date in every respect, was inspected with great interest. Excursions were made to Broeck, Volendam, the Isle of Marken, and Leyden.

The party next proceeded to the Hague, where they were received and welcomed by Mr. Lindo, the Director of Public Works, and the splendidly-equipped abattoirs were then inspected with special interest. The party drove to Scheveningen, visiting the "House in the Wood," and afterwards inspected some of the world-famed picture galleries of the Hague.

Honorary Members.

In view of the great interest shown, and in return for the services kindly rendered, by Mr. Bos and Mr. Lindo, the Council have elected these gentlemen as Honorary Members of the Institution.

The Finances.

The accounts which accompany this report for the financial year ending April 30th, 1913, have been duly audited by the Official Auditors, Messrs. Wood, Drew & Co., and are presented with this report. It will be seen from the figures that the Institution is in an exceedingly satisfactory financial position.

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Dr. INCOME AND EXPENDITURE ACCOUNT

EXPENDITURE.	£ s. d.	£ s. d.
To Reports of Meetings	..	81 16 0
„ Examiners' Fees and Expenses	..	80 7 8
„ Printing, Lithography, and Stationery (including Postage)	..	831 6 5
„ Expenses of Meetings	..	77 7 7
„ Rent of Office and Coals	..	90 8 9
„ Bankers' Charges	..	0 11 3
„ Telegraphic Address and Telephone	..	18 18 9
„ Expenses of Delegates and Affiliation	..	18 0 10
„ Donation to International Road Congress	..	105 0 0
„ Premiums	..	8 8 0
„ Law Reports and Parliamentary Papers	..	9 5 4
„ Salaries	..	615 0 0
„ Office Expenses (including Typist and Expenses of Removal to New Offices)	..	107 9 4
„ Petty Cash—		
Postage	..	40 2 3
General	..	5 8 2
„ Legal Charges	..	92 0 4
„ Audit Fee	..	15 15 0
„ Amounts written off—		
Subscriptions	72 14 0	
Investments	98 13 2	
Office Furniture	10 19 9	
		182 6 11
		2379 12 7
„ Surplus for Year carried to Accumulated Fund	..	345 7 9
	£	2725 0 4

Dr. BALANCE-SHEET ON

LIABILITIES.	£ s. d.	£ s. d.
To Sundry Creditors	..	191 1 8
„ Premiums in respect of Volume XXXVIII.	..	8 8 0
„ Subscriptions in advance	..	24 0 0
„ Accumulated Fund—		
Balance at April 30, 1912	2395 6 8	
Add Surplus for year ending April 30, 1913	345 7 9	
		2740 14 5
		£2964 4 1

Report to the Members of the Institution of Municipal and County Engineers.

In accordance with the provisions of section 113 of the Companies (Consolidation) Act, 1908, we report that we have examined the above Income and Expenditure Account and Balance Sheet with the books and vouchers and have obtained all the information and explanations we have required. The Balance Sheet in our opinion is properly drawn up so as to exhibit a true and correct view of the state of the Institution's affairs according to the best of our information and the explanations given to us, and as shown by the books.

(Signed) Wood, Drew & Co. (Chartered Accountants), Auditors to the Institution.
139, Cannon Street, London.

92 Victoria Street,
Westminster, S.W.

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FOR THE YEAR ENDING APRIL 30, 1913. Cr.

INCOME.	£ s. d.	£	s.	d.
By Subscriptions ..	..	2068	7	6
„ Entrance Fees ..	..	267	8	0
„ Examination Fees ..	..	268	16	0
„ Sale of Proceedings ..	..	86	12	7
„ Interest on Investments and on Deposit ..	..	83	16	3
	£	2725	0	4

APRIL 30, 1913. Cr.

ASSETS.	£	s.	d.	£	s.	d.
By Cash—						
at Bank ..	208	6	9			
in Hand ..	11	9	2			
				219	15	11
„ Investments—						
£190 Southampton Corporation 3½ % Stock at 92	174	16	0			
£553 2s. 9d. India 2½ % Stock at 63½ ..	351	4	10			
£650 0s. 3d. London County 2½ % Stock at 65 ..	422	10	2			
£200 Metropolitan 2½ % Consolidated Stock at 74	148	0	0			
£407 11s. 9d. New South Wales 3½ % Stock at 94	383	2	8			
£600 India 3½ % Stock at 90 ..	540	0	0			
				2019	13	8
„ Subscriptions in Arrear ..	540	1	0			
Less Reserve ..	150	0	0			
				390	1	0
„ Amount due for Sale of Proceedings ..	..			4	7	6
„ Stock of Proceedings—estimated value ..	..			100	0	0
„ Office Furniture ..	..			230	6	0
			£	2964	4	1

R. J. Thomas (*President*).
James Lemon (*Hon. Treasurer*).
Charles Jones (*Hon. Secretary*).
Thomas Cole (*Secretary*).

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During the year, abnormal expenditure amounting to over 200*l.* has been met out of revenue for furnishing the new offices.

The arrears this year are unduly high, despite repeated applications for payment. Exceptional circumstances, which will in due course right themselves, have tended to swell the total.

The Council earnestly trust that Members will give immediate attention to applications for payment, as it is evident from the amount of arrears recovered during the past year that forgetfulness is the chief cause of this undesirable item in the accounts.

The New Home of the Institution.

The Council have acquired a lease of a large and well-lighted suite of offices at 92, Victoria Street, Westminster. Better accommodation is now given for the increased work of the Institution and for holding the Council, Committee, etc., meetings, and the rooms have been used for the purpose of district meetings during the year, and for receiving deputations. By the adoption of movable partitions, an area of nearly one thousand square feet uninterrupted floor space is available at any time it may be required. The dimensions of the rooms are as follows:—Council chamber, 25 feet by 19 feet; two rooms, each 20 feet by 12 feet 6 inches, and a smaller room, 13 feet 6 inches by 11 feet 6 inches.

Development of London.

The Council were approached by the Royal Institute of British Architects with reference to participation in a deputation of various interested bodies to the Prime Minister to urge upon him the necessity of legislation to deal with the consistent, dignified, and practical development of Greater London, by co-ordinating existing bodies for the special purpose of creating a system of main roads. The Council informed the Royal Institute of their hearty agreement with the object of the petition, and the President accordingly became a signatory on behalf of the Institution. The Prime Minister consented to receive the deputation on the 3rd of July, 1913.

Deputation to Mr. Asquith.

Mr. Asquith, who was accompanied by Mr. John Burns, the President of the Local Government Board, and Sir George Gibb,

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Chairman of the Road Board, at the House of Commons, on July 3, received two deputations, who urged upon him the importance of having some central body to assist Local Authorities around London in town-planning schemes, particularly with reference to main roads.

One deputation represented the Institution of Municipal and County Engineers, the Royal Institute of British Architects, the Surveyors' Institution, and the London Society, and the other was representative of the Local Authorities and certain societies interested in town planning.

The President, Mr. R. J. Thomas, spoke on behalf of this Institution, the other speakers being Sir Aston Webb for the Royal Institute of British Architects, Mr. Leslie Vigers for the Surveyors' Institution, and Mr. Raymond Unwin for the London Society.

Mr. Asquith stated in his reply that he would suggest that the Local Authorities should come into conference with the President of the Local Government Board, who was quite willing to lend his services, and, if they are willing, to take Mr. Burns as their chairman with regard to the matter, and see if they could hammer out by agreement a plan which would meet the two sets of interests. He further suggested that the deputation should put themselves into communication with Mr. Burns without any unavoidable delay, and that the various interests should be heard in mutual conference. Mr. Asquith agreed that there should be some central authority, but as to the character and precise functions of any such authority, that was a matter he would like to reserve for further consideration.

INTERNATIONAL ROADS CONGRESS, LONDON, 1913.

The third International Roads Congress was held in London in June last. Inasmuch as the construction and maintenance of highways form so large and important a part of the work of the Municipal and County Engineer, the Council felt it their duty to take their full share in the work of this Congress.

Many Members of the Institution have served upon the various committees of the Congress, a large number of the papers read and discussed were contributed by Members, and the Council made a donation of one hundred guineas towards the expenses of the work of the Congress.

The condensation of the various papers, in order to comply

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with the requirements of the permanent Committee, was so severe that the reports and recommendations to the Congress had necessarily to be in general terms, whilst the time at the disposal of the Congress was so brief, after the delay necessitated by translating into three languages, that it was impracticable to discuss details. Unfortunately, a large number of the delegates did not receive the papers or the general reports, and were therefore unable to follow all the recommendations made in the latter. The opportunity afforded for personal intercourse and friendly discussion has, however, done much to advance the science of road-making and to cement international friendships.

Mutual Defence Fund.

The Council have given careful consideration to this matter, but the response from the Members has been disappointing. The subject is still occupying the attention of the Council.

President's Prize.

The President and Council regret that as no paper has been contributed by a student during the past year, this prize cannot be awarded.

Premiums.

The Council have awarded an Institution premium of £5 5*s*. 0*d*. to Mr. E. R. Matthews for his paper on Bridlington Municipal Works, and of £3 3*s*. 0*d*. to Mr. H. W. Barker for his paper on Cemetery Construction and Sub-Soil Drainage.

Unfair Treatment of Members.

The attention of the Council was drawn by a Member to the unfair treatment to which he had been subjected by a portion of the Council of the Authority he served.

The Secretary was instructed to interview certain members of the Local Authority, and the Council are glad to report that matters were subsequently satisfactorily adjusted.

Arbitration Clause.

As stated in the last Annual Report, the Council have given further consideration to representations from the National Federation of Building Trades Employers, and have had the advantage of receiving a deputation from their body. The Arbitration

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Clause Sub-Committee finally recommended that the clause as set forth in the last Annual Report (*vide* "Proceedings," Vol. XXXVIII., pp. 462, 463, 464) be adhered to, with the exception of item "n" "as to the issuing of certificates relating to payments to the contractor." This item the Sub-Committee recommended should not be withheld from arbitration. The Council adopted the report, and resolved accordingly.

MAIN- AND SUB-CONTRACTORS.

A deputation from the Confederated National Association of Master Plasterers, Plumbers, and Slaters, was received by the Council, in support of proposed clauses dealing with the relationship between main- and sub-contractors, for insertion in contracts. On the report of the Arbitration Clause Sub-Committee, to whom the matter was referred, the Council resolved that the clauses were not such as could be recommended for adoption by the members generally, as the principle of sub-contracting does not apply to the London and South and West of England Districts. The clauses were, however, referred to the Executive Committees of the North-Eastern, North-Western, East Midland, and West Midland Districts, and are at present receiving consideration.

TECHNICAL QUALIFICATIONS.

The attention of the Local Government Board was called by the Council to the undesirability of the appointment of persons lacking the requisite engineering training and experience, to the post of Engineer and Surveyor to Local Authorities, and a similar letter was sent to an Authority which had made such an appointment.

HOME EXAMINATIONS.

During the year three examinations have been held, for which 83 candidates entered (74 presented themselves) for examination. Forty-two candidates satisfied the examiners and have been granted the testamur of the Institution.

The Council trust that members, in fairness to the candidates who expend both time and money in preparing for the examination, will accord the fullest possible recognition to possession of the testamur, when making appointments to their staffs.

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Colonial Examinations.

It is hoped to hold a South African examination in October next, and arrangements are also being made for the holding of an examination in India.

Hong Kong, Colombo, and Singapore are also receiving attention as possible examination centres.

Visit of French and Belgian Engineers.

The Association des Hygienistes et des Techniciens Municipaux visited London in October. Mr. W. B. Bryan, Chief Engineer to the Metropolitan Water Board, assisted by your Secretary, made the necessary arrangements and acted as guides to various engineering works. The Association paid the Institution the graceful compliment of electing your Secretary as an Honorary Member of their body.

Public Hoardings.

The question of limiting and controlling hoardings, has received the attention of the Council, by whom it was referred to a Sub-Committee for consideration and report. The Council considered the report prepared by Mr. J. S. Brodie of sufficient value to warrant its printing and circulation to the membership, and it was accordingly issued to all on the roll of the Institution.

Proceedings in Journal Form.

Pursuant to the wish generally expressed at the last Annual General Meeting, arising out of a suggestion contained in a Paper by Mr. A. H. Campbell, the question of the publication of the Proceedings of the Institution in the form of a "Journal" has occupied the attention of the Council during the past year.

It has been felt that the yearly issue of the Volume in its present form, appearing of necessity at a considerable period after the close of the Presidential year, no longer efficiently meets the requirements of the members for close touch with the work of the Institution.

It has been therefore decided to discontinue the yearly issue and to establish a "Journal" to be issued in monthly numbers, and in April, May, June and July twice monthly.

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In this will appear papers and discussions, and all notices which can conveniently and usefully be included. Special articles will appear from time to time, and it is intended to afford a means whereby the Members generally will be able to discuss matters of professional interest.

By the acceptance of selected advertisements, which will appear at the beginning and end only of each issue, the Council trust materially to reduce the present heavy total cost of printing.

No advertisements will be included in the text, and binding cases will be obtainable from the printers on the completion of the year's issues, by those who desire to bind the numbers in the form of a volume.

The first issue will be in the hands of the Members as soon as possible after the conclusion of the Annual Meeting.

Index to the Proceedings.

A cross reference index to Volumes 31 to 37 is in course of preparation and, it is hoped, will be ready for issue shortly.

REPORTS FROM DISTRICT HONORARY SECRETARIES.

West Midland District.

District Chairman—A. T. Davis, M.Inst.C.E.
District Representative—A. T. Davis, M.Inst.C.E.
District Secretary—F. C. Cook, A.M.Inst.C.E.

Two meetings of the Members of this district have been held during the year under review. The first was held at Birmingham on November 21, 1912, at which Mr. H. E. Stilgoe, M.Inst.C.E., City Engineer, Birmingham, gave a very interesting address on the Town Planning schemes adopted by the City Corporation. At this meeting an Executive Committee for the District was elected, and the Members received, with very great regret, the resignation of Mr. H. Richardson, who had for many years filled the office of District Secretary.

The second meeting was also held at Birmingham on January 23, 1913, at which an interesting discussion on the Report of the Departmental Committee of the Local Government Board on Intercepting Traps in house drains, was opened by

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Mr. E. B. Savage, A.M.Inst.C.E., City Engineer's Department, Birmingham, and Mr. A. J. Dickinson, Surveyor to the Urban District Council, Redditch.

In addition to the above, two meetings of the Executive Committee have been held in connection with matters of moment to the District.

SOUTHERN DISTRICT.

District Chairman—R. Read, A.M.Inst.C.E.
District Representative—L. S. McKenzie, A.M.Inst.C.E.
District Honorary Secretary—F. R. Phipps, A.M.Inst.C.E.

A Southern District meeting was held at Southampton on Saturday, February 22, 1913. The Members assembled at the Town Hall, where they were received by His Worship the Mayor, Councillor H. Bowyer, R.N.R. Entering conveyances, the Members proceeded to visit the works of the Trinidad Lake Asphalte Paving Co., inspecting *en route* roads constructed and in course of construction by the Company. A visit was then paid to the Northam swimming bath. After luncheon, the Members returned to the Town Hall. An Executive Committee for the Southern District was elected.

An interesting paper, descriptive of the Northam open-air swimming bath, constructed in ferro-concrete, by Mr. J. A. Crowther, Borough Engineer, Southampton, was then read and discussed.

EASTERN DISTRICT.

District Chairman—A. Fidler, M.Inst.C.E.
District Representatives—W. H. Prescott, M.Inst.C.E.; H. T. Wakelam, M.Inst.C.E.
District Honorary Secretary—E. J. Elford.

Two meetings of the Institution and four district meetings have been held in the Eastern District during this session. The Institution meetings were held at Grays and Gerrards Cross respectively, and were both well attended. At the former a paper entitled "Municipal Works at Grays" was read by Mr. A. C. James, A.M.Inst.C.E., and an interesting series of visits followed, including the Grays open-air swimming bath and recreation ground, the Wouldham Cement Co.'s works, and the works of Messrs. Siegwart, Ltd.

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At the Gerrards Cross meeting a paper descriptive of the New Sewage Disposal Works, Gerrards Cross, was read by Mr. A. Gladwell, Engineer and Surveyor to the Eton Rural District Council. The works were formally opened in the presence of the Members, by Col. The Hon. W. Le Poer Trench, C.V.O., R.E.

The District meetings were held in London, and were well attended. In addition to the transaction of District business discussions took place on papers upon the following subjects, viz. :—

The Report of the Departmental Committee of the L. G. B. in reference to the use of Intercepting Traps in House Drains, introduced by Mr. H. P. Boulnois, M.Inst.C.E.; "Modern Methods of Water Purification," by Dr. J. C. Thresh; "Widths, Diameters, and Weights of Road Wheels," by Mr. A. E. Collins, M.Inst.C.E. The advantage or otherwise of the publication by the Press of Papers read at meetings of the Institution by Mr. C. Vawser, and the proposed Mutual Defence Fund by Mr. H. T. Wakelam, M.Inst.C.E.

A District Executive Committee was elected at the Grays meeting in September, and two meetings were held during the session.

NORTH-EASTERN DISTRICT.

District Chairman—F. Massie, M.Inst.C.E.
District Representatives—E. B. Martin, M.Inst.C.E.; E. R. Matthews, A.M.Inst.C.E.
District Honorary Secretary—J. P. Wakeford, A.M.Inst.C.E.

Since the last Annual Meeting one meeting of the Institution has been held in this District at Newcastle-upon Tyne, on May 2 and 3, 1913. Papers were read by Mr. W. J. Steele, M.Inst.C.E., City Engineer, and three members of his staff, Messrs. Hubert Laws, F. I. Morgan, A.M.Inst.C.E., and J. McKellar, the respective subjects being "Notes on Municipal Works in Newcastle-upon-Tyne," "Newcastle Quayside Extensions," "Ouseburn Valley Works, Newcastle-upon-Tyne," and "Newcastle-upon-Tyne Tramway Extensions." The Members were kindly received by the Lord Mayor and the Sheriff, who extended to the Institution a cordial official welcome. On the afternoon of the Friday the Members were afforded an opportunity of a cruise down the River Tyne, in a steamer kindly placed at the disposal of the Institution by the River Tyne Commissioners,

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and on the afternoon of Saturday exceedingly interesting and instructive visits were made to the Quayside, Ouseburn Valley Works, Benton Bank Bridge widening and tramway, and Jesmond Dene.

During the year two District meetings were held, viz., at York, on November 30, 1912, and at Leeds, on March 8, 1913. At the former meeting a paper was contributed by Mr. F. W. Spurr, City Engineer, on "Works in hand at York."

At the meeting held in Leeds a paper was contributed by Mr. W. T. Lancashire, M.Inst.C.E., City Engineer, on "Some Municipal Works and Practice in Leeds."

The Session of 1912–13 may be regarded as a most successful one, both from the point of view of meetings and increase in membership, the numbers on the roll in this District now being 115 Members, 28 Associate Members, and 7 students.

North-Western District.

District Chairman—J. A. Brodie, M.Inst.C.E.
District Representatives—C. Brownridge, M.Inst.C.E.;
W. Stubbs, A.M.Inst.C.E.
District Hon. Secretary—A. W. Bradley, M.Inst.C.E.

A District Meeting was held at Blackpool on November 16, 1912. The business was of a formal and preliminary character. Mr. J. S. Brodie, the Borough Engineer and Surveyor of Blackpool, gave a brief description of the Princess Promenade works, which were inspected.

On March 1 a District Meeting was held at Stretford, at which an Executive District Committee was elected. Mr. E. Worrall, the Surveyor to the Stretford Urban District Council, read a short paper on "Asphalte Street Pavements," which was fully discussed. Afterwards several streets illustrating that type of street construction were inspected, as well as the Old Trafford Baths, Seymour Park Schools, and Technical Institute.

Promises of future meetings to be held at Blackburn, Colne, Darwen, Leigh, Lytham, and Rochdale have been given, and it is hoped that meetings will be held in Bolton and Manchester also during the coming year.

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Metropolitan District.

Chairman—J. Patten Barber, M.Inst.C.E.
District Representatives—Norman Scorgie, M.Inst.C.E.; O. E. Winter, A.M.Inst. C.E.
Hon. District Secretary—Norman Scorgie, M.Inst.C.E.

As and from March 18, 1912, to April 2, 1913 (inclusive), four meetings were held, the first at Caxton Hall, and the others at the offices of the Institution. It was hoped that more could have been arranged, but owing to the large number of other District meetings held in the Metropolis, it was impossible to fix convenient dates, and for this reason it was found impracticable to call meetings monthly, with an occasional social evening, as was suggested at the commencement of the year. It is, however, hoped that these may be arranged for in the future.

The matters dealt with at the various meetings have included, among others: The question of a conference with the Superintending Architect respecting Part VII. of the London Building Act, 1894, in relation to temporary buildings and wooden structures; the draft by-laws of the London County Council as to overhanging lamps, signs, etc.; the influence of motor traffic on Metropolitan roads; a Mutual Defence Fund, and a suggestion from the North-Eastern District that the meetings of the Council of the Institution should be held in various parts of the country, instead of always in London as at present.

When the question of the formation of a Mutual Defence Fund came before the Members present at the meeting, it was favourably entertained, and the hope expressed that the whole of the members of the district would cordially support its adoption.

The suggestion of the North-Eastern District was carefully considered, but, in the opinion of the meeting, the question was entirely one for the Members of the Council to determine, and not one on which a District meeting could express any decision.

A very instructive and interesting discussion took place on the question of the influence of motor traffic on Metropolitan roads, and amongst other subjects touched upon by the Members were the regrouting of granite sett paving, the requirements under the Locomotive Acts and the Heavy Motor Car Order limitation of routes, etc.

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At the conclusion of the meeting held on December 13, 1912, Members and friends adjourned to Lyon's Victoria Mansions Restaurant, Victoria Street, where a most enjoyable social and musical evening was spent; so much so, in fact, that all present expressed the hope that many more such gatherings might be arranged in the future.

North Wales District.

District Chairman—W. Jones, Assoc.M.Inst.C.E.
District Representative—J. Price Evans.
District Hon. Secretary—J. England.

Owing to the great distance apart of the towns, it is found to be very difficult to arrange meetings within the district convenient to all, and this, combined with the Chairman being indisposed during the greater part of the winter months, has prevented a series of half-day meetings being arranged as was intended.

During the year, three meetings have been held, two at Colwyn Bay and one at Wrexham, the two first named being informal for the purpose of nominating the Chairman, Representative, and Hon. Secretary for the district.

A paper entitled "Wrexham and its Municipal Works," prepared by Mr. England, Borough Engineer, was discussed, a visit afterwards being made to various municipal works.

Scottish District.

District Vice-President—J. Bryce, M.Inst.C.E.
District Chairman—J. Bryce, M.Inst.C.E.
District Representative—J. Young.
District Honorary Secretary—D. Ronald.

A Scottish District meeting was held in Falkirk on December 21, 1912, for the purpose of considering the formation of three Committees, viz., a Roads Committee, Housing and Town Planning Committee and a General Purposes Committee. These Committees were formed and consist of 9, 8, and 13 Members respectively. It was also agreed to circularise the Local Authorities, pointing out that these Committees had been formed and asking their co-operation in the work of the Institution. It was stated by the Chairman that the Roads Committee

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was being formed primarily to collect and tabulate scientific data as to improved methods of road construction and particularly the effect of climatic conditions in conjunction with traffic returns on experimental road lengths to be laid down in Scotland having distinctive climatological conditions.

Joint Meeting of Roads, Housing and Town Planning Committees. January 10, 1913.—The Honorary District Secretary read a letter from the Secretary of the Local Government Board intimating that they had disposed of the Model By-laws drawn up by the Institution and that the Secretary for Scotland had them now under consideration.

It was agreed that Mr. A. Horsburgh Campbell and Mr. J. E. Wilkes be put forward as nominees for election to the Council.

Roads Committee Meeting. January 10, 1913.—Mr. J. Walker Smith was elected Chairman of the Roads Committee, and Mr. W. H. Wainwright was elected Committee Secretary.

General Purposes Committee Meeting. January 10, 1913.—Mr. A. Horsburgh Campbell was elected Chairman, and Mr. D. A. Donald was elected Committee Secretary.

The following were appointed correspondents to collect, etc., information of the following matters:—

Main drainage	W. Forbes.
Tramways and transit	J. Young.
Water	C. Massie and W. Watson.
Hospitals and sanatoria	A. Stevenson.
Statistical returns	J. Young and A. Forbes.
Superannuation	J. Bryce.

The information to be sent to the Committee Secretary by March 31, and to be submitted to a committee meeting to be held for that purpose. The information so collected to be kept by the Honorary District Secretary for the use of Scottish Members, a copy to be sent to the General Secretary in London for the use of the Institution.

Town Planning Meeting. January 10, 1913.—Mr. John Bryce was elected Chairman, and Messrs. W. A. Macartney and J. E. Wilkes, Committee Secretaries. Mr. Wilkes was instructed to see the Local Government Board and to offer to place at their disposal the experience of the Committee in framing further regulations relative to Town Planning.

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It was agreed to visit Dunfermline on Saturday, February 1, 1913, to inspect the Town Planning Schemes in connection with Rosyth development.

A Meeting of the Scottish District was held on March 6, 1913. Mr. J. Bryce, Vice-President, occupied the chair. The Meeting was called to consider nominations for district officers and it was agreed to recommend the following: Vice-President—Mr. John Bryce; District Chairman—Mr. F. G. Holmes; District Representative—(*a*) Mr. A. Horsburgh Campbell; (*b*) Mr. John Young; District Secretary—Mr. David Ronald.

A letter was read by the District Secretary from the Convention of Royal Burghs asking for suggestions to the amending Schedule IV. of the Burgh Police Act, 1892, in connection with the Police Amendment Bill. The letter was remitted to the By-laws Committee.

In addition to the work undertaken at the above meetings, evidence on behalf of the Institution is being given before the Royal Commission on Housing by Messrs. A. Horsburgh Campbell, John Young, A. Stevenson, J. E. Wilkes, and James Thomson.

A meeting of the By-laws Committee and the Convention of Royal Burghs was held on March 14, and the question of amending Schedule IV. and other clauses of the Police Acts was discussed.

It was agreed that the By-laws Committee draw up an amended schedule in place of Schedule IV. and forward same to the Convention for inclusion in the Police Amendment Bill. The meeting was held on April 4 and the new schedule has been forwarded.

The District Secretary is putting himself into communication with engineers, surveyors, and assistants, who are not in the Institution, and who are qualified for election, with a view to enlisting them into the Institution.

The District Secretary is endeavouring along with the General Secretary to form a students section of the Scottish district, and is prepared to give his assistance to the Secretary of this branch when formed.

The annual summer meeting was held at Dundee.

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From the Honorary District Secretary's Office 1109 letters and circulars have been sent out, and 203 letters have been received.

South Wales District.

District Chairman—W. Harpur, M.Inst.C.E.
District Representative—G. A. Phillips, A.M.Inst.C.E.
District Honorary Secretary—H. Alex. Clarke.

On March 23, 1912, a meeting of the South Wales District was held at Cardiff, when the following nominations were made. District Chairman—Mr. W. Harpur, City Engineer, Cardiff; District Representative—Mr. Geo. A. Phillips, County Surveyor, Bridgend; District Secretary—Mr. H. Alex. Clarke, Surveyor, U.D.C., Briton Ferry.

Much correspondence has passed between the District Secretary and the Members during the year. The first district meeting was held at Swansea on January 11, 1913, to elect an executive committee.

The Mayor of Swansea offered the Members of the Institution a hearty welcome, and the President, Mr. R. J. Thomas, thanked the Mayor for the cordial welcome which he had given the Members of the Institution.

Various works completed and in course of construction were visited, and the Deputy Borough Surveyor, Mr. Geo. Swarbrick, presented a paper on the "Swansea Tramways," and the Assistant Borough Surveyor, Mr. G. H. Bell, presented a paper on "The Development of the Pentre Valley in relation to the Destructor." These papers resulted in considerable discussion, and notwithstanding the unfavourable weather the meeting was a successful one.

The Executive Committee have met and discussed questions for furthering the interests of the Institution, and with the object of placing before gentlemen eligible the benefit of becoming Members of the Institution.

Arrangements are being made for district meetings to be held at Cardiff and Neath during the summer months.

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South-Eastern District.

District Chairman—A. Dryland, M.Inst.C.E.
District Representative—J. L. Redfern.
District Honorary Secretary—F. Roberts, A.M.Inst.C.E.

September 20, 1912.—District Meeting at No. 11 Victoria Street.

An Executive Committee was formed, consisting of four representatives from each county, viz. Kent, Surrey and Sussex.

A paper was read by Mr. J. L. Redfern, Borough Surveyor, Gillingham, on "Superannuation, Security of Tenure, and Mutual Protection." Mr. Redfern was thanked by the Chairman for his paper, and a discussion followed, in which Mr. R. J. Thomas, Mr. H. P. Maybury, and others, took part.

Mr. Redfern was requested to send a summary of the paper to the professional journals.

October 26, 1912.—Executive Committee, when it was resolved to hold a meeting at Sidcup, to be followed by a dinner in London.

December 7, 1912.—Executive Committee Meeting, when various details of the meeting to be held at Sidcup were arranged.

January 8, 1913.—A most successful district meeting was held at Sidcup, to examine the experimental lengths of road laid down for the Road Board by the Kent County Council.

The Members traversed the sections, commencing at the New Eltham end, examining them with much minuteness, whilst Mr. Maybury gave many valued explanations. On arriving at the Sidcup end the Members held a meeting under the chairmanship of Mr. A. Dryland, where Mr. Maybury gave interesting particulars of the cost of construction, reconstruction, scavenging and repairs, and the total expenditure as returned to him by the manufacturers. The Members were afterwards entertained to tea by Mr. Maybury, and at the conclusion of the meeting hearty thanks were accorded him for contributing in so many ways to the success of the arrangements.

In the evening the Members dined together at Frascati's Restaurant, Oxford Street, the chair being occupied by Mr. Dryland, who was supported by the President, the General

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Secretary, Mr. Maybury and some twenty-five Members. A musical programme and various toasts followed the dinner and a most successful evening terminated about ten o'clock.

East Midland District.

District Chairman—E. G. Mawbey, M.Inst.C.E.
District Representative—E. Purnell Hooley, M.Inst.C.E.
District Honorary Secretary—R. A. MacBrair, M.Inst.C.E.

The following meetings have been held during the year:—

A meeting at Ilkeston held September 28, 1912, papers were read on the Municipal Works at Ilkeston, the special Sewage Disposal Works, and their Tramway and Electricity Works. All these were inspected and a District Executive Committee formed.

A committee meeting was held in the Shire Hall, Nottingham, on November 16, 1912, when various matters of business were discussed.

A meeting of the District Committee was held at Newark, on February 15, 1913. Various matters of business were discussed.

A general meeting of the district was held at Newark, on February 15, 1913. A paper was read on Rural Housing, and a discussion ensued thereon.

South-Western District.

District Chairman—H. T. Chapman.
District Representative—T. Moulding, M.Inst.C.E.
District Honorary Secretary—T. Moulding, M.Inst.C.E.

There have been three meetings of the district held during the year; the first one at Taunton on November 16 last was very well attended, considering the area of the district, and a very useful discussion on "The Advantages and Disadvantages of Tar Macadam Roads," led by the Borough Surveyor of Taunton, took place.

The second meeting was held on April 5, at Exeter, and was also well attended. There was no paper or discussion at this meeting, as it had been called for the purpose of deciding whom to nominate as Chairman, Representative, and Secretary.

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The third meeting was held at Truro on May 30. The chairman stated that he had promised the Association of Somerset Surveyors to support the following resolution:—

"That this Association, having regard to the fact that Surveyors are now compelled to use mechanically-propelled vehicles in order to adequately inspect the roads under their supervision, are of opinion that the same facilities in the matter of taxation on vehicles, and rebate on petrol consumed, that are at present allowed the medical profession should be granted to them."

He explained that a copy of the resolution had been sent to the Chancellor of the Exchequer and the Secretary of the Institution. After some discussion, it was proposed by Mr. Brookes, and seconded by Mr. Garrett, that the resolution be supported by the South-Western District Members: this was passed *nem. con.*, and the Secretary was instructed to forward the resolution to the Secretary of the Institution.

Mr. Brookes, the County Surveyor of Cornwall, then read a few notes on "Points in connection with Road Maintenance, with particular reference to Bituminous Roads." A good discussion followed.

Mr. Brookes having replied, it was unanimously resolved that he be asked to supplement the notes, and submit them in the form of a paper, to be read either at a district meeting or the forthcoming Annual Meeting. This Mr. Brookes promised to do.

The members and visitors were afterwards entertained to supper by Mr. Brookes at the County Hall.

On Saturday, the 31st, the party paid a visit to the Bath and West Show in the morning, and were the guests of the West of England Stone Co. and the St. Keverne Stone Co. in a trip down the River Fal in the afternoon. On arriving at Falmouth, the party were met by the Deputy-Mayor and the Borough Surveyor of Falmouth, and were driven round the Castle Drive, after which the party were permitted to inspect the semi-tropical gardens owned by Howard Fox, Esq. Tea, provided by the Mayor of Falmouth, was then partaken of.

After a vote of thanks to the Mayor of Falmouth, which was replied to by the Deputy-Mayor, owing to the absence of the Mayor, the party broke up, having spent a very enjoyable day.

A digest of the meetings was sent to the professional papers.

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STANDARDISATION COMMITTEE. REPORT FOR YEAR 1912–13.

MR. E. J. ELFORD: This Committee has held a number of meetings during the year, and has had under consideration many matters relating to standardisation, in addition to which members of the Committee have been actively engaged upon a number of Sectional Committees of the Engineering Standards Committee.

Concrete Flags. The first edition of the standard specification published by the Institution was rapidly disposed of, and early in the year the Committee found it necessary to publish a second edition. Before doing this conferences were held with the Concrete Institute, and certain revisions agreed upon.

The specification is on sale by Messrs. E. & F. N. Spon, Ltd., 57 Haymarket, price 2*s.* 6*d.* per copy.

The Committee has from time to time considered matters relating to questions brought before them by the delegates to other Committees, and has decided upon the course which should be adopted by the representatives of this Institution.

TRAMWAY RAILS STANDARDISATION COMMITTEE.

MR. W. HARPUR: But little practical work has been done by this committee during the past year. At the beginning of the year other kindred institutions were given an increased number of representatives on the committee, making their numbers three from each institution, the number of representatives from this Institution being two. An application for further representation from this Institution at first met with refusal, and for a long time no meeting of the committee was held. At the meeting of the committee held recently, however, it was decided to accede to the request of this Institution for another representative, and Mr. E. J. Elford was nominated by this Institution, and has accepted a seat on the committee. Two manufacturers of manganese steel points and crossings have also been added to the committee in the persons of Mr. Brown, of Messrs. Hadfields, Ltd., and Mr. Bland, of Messrs. Edgar Allen & Co. The election of these two gentlemen became necessary owing to the decision of the committee to standardise points and crossings.

During the past year there has been shown a desire on the part of some members of the committee representing other institutions to commence *de novo* in the matter of the rail

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standards and to practically scrap the present standards. Enquiries made by Mr. Elford from the Members of this Institution who have the control of tramway track work elicited the fact that there was no desire for any such change, except from a very small percentage of track engineers, and that to commence changing the standards would be a fatal error in British standardisation. At the last meeting of the committee the proposals were defeated, but it was decided to make certain amendments in the standards, the details of which will be gone into at an early meeting of the committee. During the year a very valuable addition to the information upon rail corrugation has been the contribution of the invaluable paper on the subject of this Institution by Mr. Wakelam. The committee is desirous of making exhaustive enquiries into the question of rail corrugation, and of making recommendations for their reduction or prevention if the enquiries should result in the securing of any definite information on the subject, but before entering upon the matter in detail it has first to come before the main Standardisation Committee, to ascertain whether the question properly comes within the scope of standardisation, and, if so, whether any funds are available for prosecuting the enquiries.

REPORTS FROM DELEGATES.

ENGINEERING STANDARDS COMMITTEE ON ROAD MATERIALS.

MR. R. J. THOMAS (President): The Engineering Standards Committee having appointed a committee to consider and report upon the standardisation of road materials, the latter, which included the President, and Messrs. E. J. Elford and H. T. Wakelam, decided to consider first the question of road stone, and appointed a sub-committee composed of road engineers and stone merchants to discuss the subject. After several meetings such sub-committee arrived at an agreement upon the definition of gauges and sizes, and the petrological classification of road stone used in the United Kingdom.

Their recommendations were submitted to and approved by the General Committee on road materials, and will shortly be considered by the Engineering Standards Committee.

Should these recommendations be adopted it is confidently believed that an important step will have been taken in the direction of uniformity and simplicity in dealing with road stone.

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MR. E. J. ELFORD: Considerable time and labour has been expended in obtaining reliable information upon which to base a standard specification dealing with the gauge and size of road stone, and draft clauses have now been agreed. The subject of nomenclature of road stones, and clauses for a specification of bituminous, tar, and pitch road materials are next to be considered.

VITRIFIED WARE SEWER AND DRAIN PIPES.

MR. E. J. ELFORD: A number of meetings of the Sectional Committee have been held under the Chairmanship of Sir Maurice Fitzmaurice. Considerable difficulty has been experienced in arriving at agreement with the manufacturers' representatives on some important points, but at the date of this report a draft specification has been practically agreed upon.

STANDARD CLAUSES FOR INCLUSION IN A SPECIFICATION OF STREET LIGHTING.

MR. T. W. HAYWARD: In 1910 the Council were invited to send five representatives to a Conference to take into consideration the preparation and issue of a standard specification for street lighting. The following institutions were represented upon the joint committee:

Institution of Electrical Engineers (nine members).

Institution of Gas Engineers (five members).

Institution of Municipal and County Engineers (five members).

Illuminating Engineering Society (five members).

The Council, on the recommendation of the Standardisation Committee, appointed the following as their representatives:— Messrs. G. F. Carter, E. J. Elford, T. W. A. Hayward, E. B. B. Newton, and N. Scorgie.

A great many meetings have been held, and your representatives have been in attendance at every meeting. The standard clauses were agreed upon by the committee and were submitted to the Councils of the several institutions for approval. Your Council considered the same, and amended some of the details slightly. The amendments suggested were accepted by the joint committee. Ultimately a paper was prepared and read by Mr. A. P. Trotter, one of the members of the committee. This

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was thoroughly discussed, and as a result the committee are now (June, 1913) considering slight amendments to the draft clauses at first submitted. It is hoped the standard clauses will be issued in the near future.

NATIONAL ASSOCIATION OF LOCAL GOVERNMENT OFFICERS.

MR. NORMAN SCORGIE: During the past year meetings of the National Council have been held in London and at Birmingham. At each meeting very gratifying reports were received respecting increase of membership.

The activities of the Association have been maintained during the past twelve months.

The examination scheme inaugurated last year has been much appreciated by the younger Members engaged in municipal work, and it is felt that anything which tends to improve the efficiency and status of the clerical side of an engineer's staff must be beneficial to the department.

The superannuation question continues to maintain the premier position in the work of the Association, and every possible effort has been made during the past year to further the matter.

Additional efforts have been made to enlist the sympathy of other Associations, to secure the support of Members of Parliament, and to persuade Municipal Corporations of the mutual advantages which would be derived by a national scheme. At the several meetings of the General Purposes Committee the subject has always been in the forefront, further figures prepared by the actuary of the Association have been carefully considered, and at the meeting recently held at Birmingham a new draft Bill submitted by the Committee was considered by the National Council attended by over one hundred and sixty delegates from all parts of the United Kingdom and Ireland, at which a general and most interesting discussion ensued. After dealing with several clauses, the further consideration was adjourned to a special meeting to be held in London, at a date to be fixed, previous to the next Annual Meeting.

As foreshadowed in the last report, an Approved Society under the National Insurance Act has been formed, and it is very gratifying to place upon record that over six thousand seven hundred municipal officers have embraced the opportunity of

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joining. This is a matter in which your delegate has taken a very keen interest, and he is pleased to report that the financial result to date has been beyond expectation, whilst the Approved Societies in general have been loud in their complaints in respect of the severe drain on their funds, necessitated by the percentage of members receiving benefit. The sickness amongst municipal officers who are members of this Society has averaged only about one per cent., and if the present low rate of sickness continues, the time will not be far distant ere the fortunate members will be receiving additional benefits such as were anticipated when the Society was formed.

As a further instance of the usefulness of the Association, the Members of the Institution will note with satisfaction that financial assistance to the extent of 25*l.* has been given to Mr. Wm. Jones, Surveyor of Colwyn Bay, towards the heavy expenditure he was compelled to incur in connection with the proceedings taken in vindication of his character.

THE SANITARY INSPECTORS' EXAMINATION BOARD.

MR. CHARLES JONES (Hon. Secretary): This Board is still doing good work. Three examinations have been held during the past year, two in London and one in Birmingham; and although the number of candidates was not quite so high as in the previous year, the standard arrived at was exceptionally good, and shows a very high degree of efficiency. The total number of "passes" was 38—strangely enough, the same number of each sex, viz. 19 males and 19 females.

ENGINEERING STANDARDS COMMITTEE: CAST-IRON PIPES.

MR. G. F. CARTER: The sub-committee engaged in the preparation of a standard specification for cast-iron pipes for water, gas, and sewage has issued a draft specification which is being considered by the Sectional Committee. The specification includes, in addition to the straight pipes, complete tables of standard dimensions for special castings.

CHARLES JONES, M.Inst.C.E.,
General Hon. Secretary,
Ealing.

THOMAS COLE, A.M.Inst.C.E.,
Secretary,
92, Victoria Street, London, S.W.

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APPENDIX.

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SUPERANNUATION, SECURITY OF TENURE, AND MUTUAL PROTECTION.

A Paper read by Mr. J. L. Redfern, Borough Surveyor of Gillingham (District Representative), Member, at the first meeting of the South-Eastern District, at 11 *Victoria Street, on Friday, September* 20, 1912, *at* 3 *o'clock.*

It seems almost superfluous to discuss the desirability of superannuation. Every one is so familiar with the arguments in favour of it. The principle has been recognised by railway and other companies to be fair and just and advantageous from a commercial point of view. Several municipalities have adopted schemes, but, of the staffs in the National and Local Government services, those employed by county, municipal, and like authorities, if we except the police and elementary teachers, are alone unprovided with an official scheme of superannuation; yet in character and quality of work, in status and class, they are equal to their colleagues in the other services.

The great advantage of a superannuation scheme to employers is that they are provided with a means of gracefully dispensing with the services of old and exhausted officials, who have given their best to the common weal, but whose emoluments in the smaller towns and districts are so small that they are sorely tried in their efforts to provide for old age, and usually find it impossible to do so if they are to maintain their position and bring up their families respectably. With approaching old age and impaired powers for service on the part of officials, difficult situations arise, owing to the need o employers for the services of younger men. These situations are bridged sometimes by retaining old officials in nominal but paid capacities; but this is the exception. Thus, we have, on the one hand, employers desirous of getting rid of old and worn-out employees, and, on the other hand, old employees who, having borne the burden and heat of the day, are anxious for some means of escape from duties grown too arduous for their declining strength.

Contributory superannuation meets such cases splendidly, for while compelling thrift on the part of officials, it provides the solution which the employers desire. At the appointed age the old employee retires honourably on his deferred pay; the employer obtains the services of younger men who are more up-to-date, because more recently equipped, and every one is satisfied. Fortunately, there is a superannuation scheme for Local Government officers now within the region of practical politics. The provisions contained in the draft Bill of the National Association of Local Government Officers are

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very fair, being based on a scale of contributions ranging from 3 per cent. to 6 per cent.

We must all agree that this scale of contributions appears very ample when we compare it with that of poor law officials, whose scale ranges from 2 per cent. to 3 per cent. We are told that the actual cost of the scheme of the latter (that is, the difference between contributions and amount paid out) is equivalent to a rate of only one-tenth of a penny in the pound, and it is estimated that the charge on the rates of the National Association of Local Government Officers' scheme would amount to rather less than one-twelfth of a penny in the pound, which ought not to frighten anybody.

But superannuation is not yet attained, although the National Association of Local Government Officers continues its efforts vigorously. That body, which in about seven years has obtained a membership of 30,000, and is still endeavouring to strengthen its organisation by inviting the active support of every Association connected with county, municipal, urban, and rural authorities, has devoted an immense amount of time to the Superannuation Bill. The County Councils' Association has definitely promised its support to the Bill, while suggesting certain amendments. The Urban District Councils' Association has approved of the Bill, and the Association of Municipal Corporations has referred the question to its Law Committee. The National Association has taken steps to place the case before those Crown Ministers likely to deal with it, and has furnished them with information; but for the moment we must work and wait.

The impression prevails in some quarters that it is only necessary to ask for benefits and they will forthwith be obtainable, and a little restlessness is shown sometimes at the apparent delay, the fact being overlooked that superannuation has to be fought for as well as paid for. What is wanted is greater co-operation among members and a ceaseless campaign, because it is almost hopeless to expect Government to render assistance until there is an irresistible demand, notwithstanding the fact that it has recently dealt with the question of superannuation for teachers by assisting them to the tune of 200,000*l.*

Until recent years, there has been a singular lack of combination among Local Government Officers, who, outside their official duties, have had as few dealings with each other as Jews with Samaritans. The Trade Union movement has taught some useful lessons, which we are slowly but surely absorbing, the chief one being that only by combined and persistent effort can an improvement in the conditions of any branch of service be attained. Until the principle of National Old Age Pensions was established, it was generally thought that the Government could not be induced to favour any more special schemes of superannuation, as it would savour of class legislation, and the official classes can hardly be described as the bottom dogs. Now, however, there cannot be any reason why we should not fight for it and obtain it.

It cannot be expected, of course, that superannuation and security of tenure can be obtained solely for municipal and county engineers and surveyors, and isolated action on our part would probably prove abortive. There is the other alternative, however, namely, the co-operation of every member of the Local Government services. Parliament, municipal authorities, and the public must be educated, and the assistance of the press sought

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and obtained. Municipal officers must arouse themselves out of the apathy which has been a stumbling-block in the past, and wage a ceaseless campaign throughout the country.

Powerful support should be given to the National Association of Local Government Officers which, because it is representative of every grade of Local Government Officer, is more likely to achieve the end desired than any other organisation, provided it is possessed of adequate funds. Our own Institution contributes 6*l*. 6*s*. per annum to the National Association's funds (equal to about 1½*d*. per member), and sends two representatives to its meetings. To me this support appears to be ridiculously small, although it is all that has been asked of them—but surely the contribution should be increased very considerably. Every member of our Institution who has not joined should become a member of the National Association of Local Government Officers.

Every local authority in the kingdom should be petitioned for support to the superannuation scheme. This is a necessary prelude to any advancement with the proposal, because it is the local Councils, who, when superannuation is granted, will have to pay the difference between the contributions and the benefits, and it is quite clear that the Government will never be inclined to place any further financial burdens upon local authorities unless it can be shown that the local authorities themselves are generally agreeable. Members of local authorities are, in the main, sympathetic at the present time, though they do not care to say so.

There was a time when the question of security of tenure and mutual protection scarcely needed to be discussed by municipal officials. In those days the character of public authorities was wholly different to what it is to-day. The members of them were largely people of the leisured class, who had time at their disposal to give to the public affairs of their locality. Their tenure of office was considerably longer than now, so that officials could rely, year after year, on the continuous support of elected employers while prosecuting the various schemes for the benefit of the public. But a great change has taken place in the composition of public bodies, particularly in industrial centres, and it has destroyed, to some extent, continuity of office and policy. The class of member before referred to is gradually disappearing, and is being succeeded by men with less respect for tradition. This metamorphosis causes a good deal of friction, and in the clash the lot of officials is not always improved.

The rate at which the constitution of public bodies changes is remarkable, a few years sufficing to replace most of the members. The consequence is that the good work that officials may have done is often lost sight of by those who come fresh upon the scene. In a word, the modern official has to continually educate recruits to public bodies, and there is no finality to the task.

No official need be too thin-skinned if he can always count on the support of the public body he serves, should he be harassed by any one in the discharge of his duties. But we are often hearing of cases where an official, besides having to bear the embarrassment of attacks from outside, cannot rely on his Council to defend him or see him through.

Moreover, a cheap and entertaining sport has arisen known as "official baiting" indulged in by those foolish members of public bodies who delight to take advantage of an official's inability to retaliate. It is comforting to know that those who indulge in it do not, as a rule, achieve success, though

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they please a certain class of the gallery ratepayers, but they can, while the sport continues, afford a considerable amount of exquisite pain to a sensitive official. The harassing of officials is as unprofitable as it is senseless because it tends to sap all enthusiasm for work and quenches the spirit of endeavour in an official. The general public who read reports of official baiting think that they too are justified in abusing the officials, and mud thrown in this way has a tendency to stick unless some effort at repudiation is made. It is not to be wondered at, therefore, that most of us believe that the time has arrived when some measure of security and protection should be obtained. We are all glad to see that our own Institution of Municipal and County Engineers has awakened to the necessity for taking active measures towards securing for its members the benefits of superannuation and security of tenure, and is alive to the great need of mutual aid and protection. The Council of the Institution finding that the new memorandum, as amended by the Board of Trade, precludes the use of the Institution's funds to defray costs incurred by a member in a libel action did the next best thing, namely, to at once start a subscription list in aid of a surveyor who has been a victim of persecution, and who finds himself, after having won his case and vindicated his character, with a heavy bill to pay.

At their last meeting the Council took into consideration the appointment of a Mutual Defence Fund Committee, and the matter has been referred to the Constitution Committee. The proposal is to create a fund independent of the finances of the Institution available for the defence of oppressed officials. The suggestion has been made that it should be started on the basis of a voluntary contribution of 5s. per annum per member, which it is thought may prove sufficient for the purpose. That there is great need for such a fund is very certain, because the Council has, a number of times, been approached by some member who has sought financial aid in making his defence. Again, the Council has often been asked to help an official by making a remonstrance to his Authority when the official in question has been warned (for no apparently good reason) that his services would be dispensed with. But the Council has not hitherto been able to do much except sympathise. It is true that, in some instances, the Institution has deputed one or more of its members to interview the Authority on behalf of the official, but with little result. There is a certain amount of security of tenure involved in superannuation itself, and this defence fund is very good in its way, and better than nothing at all, but most of us feel that since we have to administer Acts of Parliament we ought to be protected by Act of Parliament. The duties thrust on officials in these days are very numerous when Acts of Parliament succeed each other with bioscopic rapidity. The application of these Acts gives rise to a good deal of public irritation, which often finds vent on the officials.

Officials are of necessity continually treading upon the toes of members of their own public bodies and of the ratepayers at large in carrying out the duties which Parliament thrusts on the Authorities, and requires the Authorities to carry out through their officials. Those members of the general public who feel themselves aggrieved by the requirements of these Acts, do not hesitate to attack the unfortunate officials who have to carry out the Acts. It is not too much, therefore, to expect that a Government which imposes upon officials the carrying out of duties which prove so repugnant to those for whom the

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Acts are framed ought to protect officials, and thus enable them to discharge their duties fearlessly, without respect of persons, and without the haunting fear that their bread and butter is at stake. Now, for one official who will go to the trouble of defending himself against an offender who slanders or libels him, there are numbers of others who feel that they dare not, because of the insecurity of their position and the risk of having to pay costs themselves, and it would be a tremendous support to officials if they had superannuation and security of tenure, and could in addition rely on the moral and financial assistance of our Institution. What one cannot understand is why security of tenure is good for officials in some branches of public service but not in ours.

It is well that officials of all classes have banded together and formed such an Association as the National Association of Local Government Officers where interests which affect all will be pushed as vigorously as possible, and it is important that every Institution and Society which deals with the welfare of Local Government Officials of any class should bear this important question of superannuation and security of tenure well in mind and let it occupy the first place in its considerations. If the situation which occurs when dealing with old servants who find they are unable to carry out their duties as formerly is suitably and profitably compassed by a scheme of superannuation at very little expense to local authorities so that they are in the position of being able to continually have the services of able and fit men, would it not also pay every authority for its officials to have security of tenure, because then the authorities would know that their officials could more fearlessly carry out all the duties imposed upon them? It is believed that there is considerable opposition at the Local Government Board to the proposal to give security of tenure to surveyors, the very Board which ought, of all, to be readiest to give support, because it is that department which is responsible for most of the work that is thrust on the surveyor.

And what is the objection to security of tenure? It is that the authority would not be able to get rid of undesirable officials. Now, this is not true, because, under any system of security of tenure, when an official did not carry out his duties satisfactorily, complaint would be made to the Local Government Board, and sufficiently good grounds for his dismissal would free the authority from his service. Does Poor Law Administration suffer through Poor Law Officials having the advantages that we desire? Whether it is because, as a body, we have no charter or not, one cannot say, but why the Local Government Board should approve of the principle of security of tenure for a medical officer of health and not a surveyor passes one's comprehension. The fear that it might establish a few unscrupulous officials is groundless, when any unscrupulous act would, of itself, be a justification for the removal of that official under any system of security of tenure. A strong representation should be made to the President of the Local Government Board on the subject, to hear his views and let him know ours about this matter. Our organisation must be strengthened, the authorities and members of Parliament must be invoked to support the principle of superannuation and security of tenure, and we must not let our efforts flag until we have achieved what Poor Law Officials enjoy. This is a very vital subject which ought to commend itself to every member of our Institution and be thoroughly ventilated at the district meetings.

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RURAL HOUSING LEGISLATION.

A Paper read by Mr. T. Lake (Member), Surveyor to the Rural District Council, Bourne, at a Meeting of the East Midland District, held at Newark, February 15, 1913.

For a long time previous to the passing of the principal Act of 1890 comparatively little had been done by private enterprise to improve or increase the housing accommodation in many of our rural areas, with the result that a cottage famine existed, which was undoubtedly bad in its effects. The provisions of this Act, however, did not apparently accomplish much to further rural housing, and, although several other Acts upon this subject were subsequently passed, it was not until that of 1909 became law that rural authorities took up the matter in a more serious spirit. In this Act of 1909 the administration and procedure are simplified, and the Local Government Board is invested with the greatest authority.

Part III. of the 1890 Act takes effect in all districts. The terms on which money may be borrowed for housing purposes are made easier. The Local Government Board has powers to make local authorities carry out their duties, and to revoke by-laws which are found to hinder the erection of dwellings for the working class. In rural districts the Rural District Councils are primarily responsible for carrying out the requirements of the Acts. Borrowing powers and the defraying of the expenses of Councils under Part III. of the 1890 Act are clearly explained.

Progress in Rural Districts.

These provisions assist materially, but, still, apparently, do not render it possible for all rural authorities in this country to erect roomy cottages which can be let to the humblest class of labourers at economic rents. It is in our rural districts that the problem exists in its most acute form. Several Rural Councils actuated by the pressing need have devoted much time to it, and have endeavoured, with excellent results, to find its remedy, and a widespread interest has been aroused by their efforts. So far, twenty-four Rural Councils in England and Wales have built 315 cottages. The rents range from 2*s.* 6*d.* to approximately 4*s.* 9*d.* per week, according, apparently, to the rate of wages prevailing in the various parts of the country.

Much has been written, and vastly more said, on how best to deal with this important question; but the real difficulty which immediately confronts the practical man is the one of building cheap cottages, with ample garden ground adjoining to let at rentals of from 2*s.* 6*d.* to 3*s.* 6*d.* per week. It has been stated frequently that the labourer can pay more than this in rent, thus

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making schemes in all cases self-supporting. If this be so little need would exist for Councils to provide accommodation, as it may be presumed that landowners and others interested would have continued to erect property that yielded a fair return. I venture to state that few of our agricultural workers can afford to pay more than the above sums, and if compelled by circumstances to become tenants at higher rentals a state of affairs may easily be created which will prove worse, in some respects, than that now existing.

The Working of a Scheme.

When the rural authority is of opinion that housing accommodation i inadequate, after representation from any part of its district, the usual procedure is to appoint a committee, the members of which are conversant with the local conditions. Such committee may then investigate the circumstances, and, if necessary, recommend suitable building sites for the consideration of the Council. Plans, estimates, and other details of the cost of the proposed scheme are submitted to the authority, and when these have been examined and approved application is made to the Local Government Board for sanction to borrow the amount required.

The Site.

In choosing sites, a very important matter in housing, the architect for the scheme should be consulted, and the following points should be borne in mind, as many economies can probably be effected thereby:—

1. The likelihood of obtaining a pure and convenient water supply.
2. The aspect of the property.
3. The state of the boundary fences.
4. The nature of the soil and subsoil.
5. Facilities for drainage where required.

Other considerations will occur to a practical mind, such as the levels of the site and its relation to the adjoining land or roadway and its accessibility. The land should preferably be freehold, and have the land tax redeemed. The area of ground considered necessary varies in different parts of the country, but one-eighth of an acre per cottage is about the average.

The Plan.

In the majority of districts, where houses are to be built, under the present Acts, for the agricultural labourer they must of necessity be of the simplest description. Much controversy has raged over the question of the accommodation necessary, and many advocates—of more or less practical experience—loudly urge the claims of a second room or parlour. To provide a sufficient kitchen and parlour adds to the cost of the houses, and must mean a corresponding increase in rent.

Most of the cottages erected on these Acts consist of a large living-room of from 1300 cubic feet to over 1500 cubic feet, with scullery and larder on ground floor, with three bedrooms over. From experience it is found that such a type meets the requirements of the people who are desired as tenants. The interior plan will be regulated by the aspect of the site, and many ingenious ideas have been brought into practice to cheapen the cost, and add to the utility of the cottage.

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Housing in the Bourne Rural District.

In the Bourne rural district two building schemes were approved in October, 1911, for the erection of 26 cottages, and these have been built in four parishes, at an average cost for building, water, and fencing, of 147*l.* per cottage, where built in blocks of four. One pair was erected, costing 150*l.* each. A further scheme for the erection of 30 dwellings in five parishes has been approved by the Local Government Board, and building is now in hand. These will be of similar design, but owing to the increased price of building materials certain economies will be effected in the exterior of the cottages. Practically the same plan has been followed, and the average cost is 149*l.* per house.

As shown on the plans, the accommodation in those already built consists of a small entrance lobby, living-room 14 feet 3 inches by 13 feet 3½ inches, with scullery 8 feet 6 inches by 8 feet, and larder 8 feet by 3 feet 6½ inches on ground floor, all of which are paved with 6-inch red tiles, laid on concrete. It may be mentioned that a good-sized larder is found convenient. There are three bedrooms over of the dimensions given; front bedroom 13 feet 3½ inches by 10 feet 1½ inch, back rooms 12 feet 1½ inch by 8 feet, and 9 feet by 8 feet 0½ inch respectively. The two larger bedrooms have fire-places, and the remaining one has a ventilator fixed in outer wall. Ashpits and pail-closets are built 20 feet distant in rear of cottages.

The water supply is principally from wells, and pumps are fixed at convenient spots. The drains from sinks empty into cesspools on the site at the distances prescribed by the Council's by-laws. In cases where proper disposal works exist, the drains may be connected to the sewer, but not otherwise.

The average cost of the land acquired was at the rate of 65*l.* per acre, and each cottage has about ½ rood of garden ground. So far, the landowners in the parishes concerned in my district, have disposed of suitable land on very reasonable terms, and such co-operation is invaluable in the working of a scheme. The houses are built of best porous Peterborough red bricks, with Excelsior stone sills, heads, and mullions. A bituminous damp course is laid on all walls 6 inches above the ground level, and all exterior walls have a 2-inch cavity, with galvanised iron ties. The roofs are slated, and have projecting eaves.

Loans were granted for land and buildings for a period of sixty years, and principal and interest are repayable in equal annual instalments.

Details of a Loan.

The following details of a loan of 1255*l.* for building 8 cottages, in two blocks of four in Rippingale parish, are perhaps of interest, and may be taken as typical of the other schemes carried out by my Council.

	£
Amount of Contract—8 cottages at 145*l.* each	1160
Land	60
Costs, stamp duties, and inquiry	35
	£1255

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Receipts.

Rents of 8 cottages (tenants paying rates), at 2*s.* 6*d.* per week £52

Expenditure.

	£	s.	d.
Repayment of loan of 1255*l.* Principal and interest at 3½ per cent. for sixty years	50	6	1
Income tax	2	10	8
Fire Insurance		18	0
Repairs, 30*s.* per cottage	12	0	0
	£65	14	9

showing a deficit on 8 cottages of 13*l.* 14*s.* 9*d.* per annum.

It will be observed there are no charges shown for architect's services, supervision, or collection of rents, such work having been carried out by the surveyor's department. There is no allowance for empties.

The houses are all occupied at present on weekly rentals of 2*s.* 6*d.*, which are collected monthly. The tenants pay the rates. A deficit of over 1*l.* per house per annum appears in the balance sheet, and that is borne by a district rate. The tenants appear to be satisfied with their cottages, and, in many cases, are grateful for the bedroom accommodation provided.

The rapidly growing numbers of Rural District Councils which have schemes under consideration, appears to justify the movement for the better housing of the working classes in our rural areas, and this must lead to a great improvement in the health, happiness, and prosperity of the labouring classes.

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ASPHALT STREET PAVEMENTS.

A Paper read by Mr. E. Worrall (Member), at a Meeting of the North-Western District, held at Stretford, March 1, 1913.

The subject was selected for a short paper at this district meeting mainly for the reason that our experience in Stretford with asphalt pavements is extensive. The many Committees of Inspection and Inquiry that have visited the district, and the inquiries also by post suggest, too, that it is not without interest to Local Authorities and their surveyors. We are not to-day concerned with the nomenclature of the subject which has of late excited so much interest in the technical press. By asphalt, is meant the natural rock asphalt imported from the Continent, and more particularly that from the Limmer Mines in the province of Hanover, West Germany. The natural deposit is there quarried in shallow mines like coal. The different veins are assayed for their percentage, ranging from 9 to 13, of pure asphalt or bitumen; the lumps are reduced to small pieces and melted in cauldrons, when Trinidad asphalt, the purest asphalt imported on a commercial scale, is added to bring up the whole to the standard of 15 per cent. of bitumen. The remainder is limestone impregnated with bitumen by nature through long ages. The standardised mixture is then run into iron rim moulds of various shapes on flat floors, and the upper side of the slab is stamped with the name and mine of the firm which has produced it. A few samples of these are in the room; others are converted and moulded in this country. Some care should be taken in admitting the latter for use in street works as, apart from the temptation and opportunity it gives the home firm to introduce other and cheaper ingredients, the required standard of bitumen contained in reliable brands imported direct from the mines may be varied.

There is a quite open market in the material, and the current price of the imported blocks is round 3*l.* 10*s.* a ton. There are in the larger samples shown about thirty-six blocks to the ton which with the added granite will cover near 20 super yards of 1½-inch work or 26 yards of 1-inch work. The introduction of this material for street paving in Stretford was due to circumstances that all present will have experienced in some degree. As in most Lancashire towns, the common type of paving previously used for many years was either the grit or the flag rock sett, of varying size and quality. This was doubtless a marked advance on gravel, cinders, and the early rubble and macadam road surfaces, but the growing call for something better and more suited to changing conditions and ideals, particularly in residential streets, became insistent. The tar paving had been tried here in some dozen streets, but their condition soon indicated that durability and

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economy in maintenance would not be attained with it. The maintenance in fact became so excessive that it was eventually decided to repave these streets with rock asphalt.

The repayment of loans herefor was sanctioned by the Local Government Board for periods of twenty years for the concrete bed, and ten years for the asphalt. It had been computed that the annual instalments of the loans would be less than the maintenance cost of the tar paving, hence the course taken. The loan periods sanctioned by the Local Government Board for asphalt pavements indicate the conservatism of that body and the careful hesitation with which it accepts new methods and proposals rather than the useful life of the material. In this connection members will be familiar with the anomaly perpetuated by the Board in the short period of ten years granted to loans for work in reinforced concrete. The generally accepted opinion that its life will be a good multiple of that term and the fact that several other Government Departments have extensively adopted the system seem to find no recognition with the engineering advisers of the Board. The same disability attends the use of asphalt for street pavements. In our opinion a loan period of twenty years, as in the case of flags and setts, would be amply justified. However, most of our work in rock asphalt has been in private streets completion, and here the maximum loan term for any material of seven years imposes no special disability.

It is doubtless in this direction, at any rate for a while, that asphalt pavements will extend, and with a greatly extended use of the material it may reasonably be expected that the Board will recognise its merits and encourage its use in public street works by granting a longer term of loan repayment. The series of plans on the table for inspection show typical cases of its use in Stretford. Prior to our amended by-laws of 1911, front streets here were formed 36 feet wide only, except where the estate owners voluntarily made them wider in what may be termed secondary streets; so the bulk of the asphalt work done relates to these 12-yard streets. In parenthesis it may be said that except in garden streets—of limited occurrence—where the space of 60 feet between house fronts may be divided into gardens and street 20 feet wide respectively, the required street width is now 42 feet minimum, and in the case of main streets 50 feet. The 36-feet street is apportioned to a carriageway of 7 yards and two paths of 2½ yards in width. The initial lay-out, draining, forming, curbing, and ballasting is done by the landowners, the de Trafford Trustees, who own 95 per cent. of the district area, and it may be here acknowledged that the trustees and their advisers show a healthy recognition of public requirements, and cordially assist the Council in its work. The sewers are mostly 12-inch, 15-inch, and 18-inch stoneware pipes, the surface drains 6-inch, and the gullies of the same material—spaced 25 yards to 30 yards apart on each side of the carriageway; the curbs are 12-inch by 8-inch Rochdale stone laid flat, and the ballast formation is furnace cinders—obtainable locally in unlimited quantities. This initial drainage and formation in a 36-feet street costs near 40*s*. a lineal yard over all.

In a number of cases broken stone has been substituted for cinder ballast with a view to its subsequent use as aggregate in the concrete, thus saving some removal of material from the site. When this is done the fact is noted

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on the completion quantities and credit thus obtained from the contractors tendering for usable materials on the site in the work. A binding and surfacing of cinders is only needed in these cases. The foregoing states briefly the local conditions when the contractor for the completion work enters upon the site. The formation work has served its purpose in giving access for building operations on the adjacent land; and the Council having ordered and taken the statutory proceedings under Section 150 of the Public Health Act, 1875, the work is let by public tender. The contractor's first operation is to relay the curbs to levels on 6-inch of 4½ : 1½ : 1 cement concrete; if the curbs need it they are also redressed and jointed. The curbs have invariably settled by unequal subsidence on the new formation. Our experience has shown, too, that when they were not afterwards founded on an unyielding concrete bed, the adjoining pavement being necessarily so founded, the curbs have settled between it, and for the past few years we have accordingly required the curbs also to be on concrete. The curbs being thus relaid to "bonings," they form the level from which all others are taken.

The carriageways and paths are next excavated 7½ inches and 4 inches respectively below finished surface levels, thus allowing for 6 inches of concrete and 1½ inch of asphalt in the carriageway, and 3 inches and 1 inch of the same respectively in the paths. Where there is little or no end fall in the street, as is commonly the case in a flat district like Stretford, the clearance or water tables must be got in the channels by grading the under-bed about 13 inches deep at the gullies, and 10 inches at the summit midway between them. The cross fall or camber of a 21-foot carriageway with the curbs, lies between 1 in 25 at the gullies, and 1 in 50 at the summits. The specification provides for near the average, 1 in 36. The irregular incidence of crossings on the paths interferes with the correct position of summit and gully in the channels, hence a close approximation to standard falls can only be obtained in practice. In a 42-feet street with an 8-yard carriageway, similar contours are obtained by raising the crown 1 inch above the curb level. Our current specification for the work embodies the result of local experience. Conciseness, simplicity and directness in its clauses has been aimed at besides the avoidance of that prolix verbiage which is seldom read, and which is a too common feature of engineering and other specifications. I cannot do better perhaps than give it here.

November 12.

STRETFORD URBAN DISTRICT COUNCIL.

Specification of Materials and Work in Completing Streets in Granited Rock Asphalt.

Portland Cement.—The cement used throughout the work shall be "Portland" of English manufacture, and of an approved firm and brand. It must be of *first* quality, and in all respects comply with the specification of the Engineering Standards' Committee.

Sand.—The sand for concrete and mortar shall be perfectly clean, sharp, of uniform size, and, if required by the surveyor, shall be washed. None shall be obtained from the site of the works.

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Water.—The contractor may obtain water from the hydrants, if any in the roads, but he shall make all necessary arrangements with the water authority, observe their regulations, and pay their charges in connection with and for the supply.

Excavation.—The contractor shall take up and cart where directed within the district all the existing sett paving, cinders, etc., as the property of the Council, and the spoil to the contractor's own tip; the bed ground shall be formed to the proper camber and gradients to permit of a layer of concrete of an even thickness of 6 inches throughout in the carriageways, 3 inches in the footpaths, and 4½ inches in the passages, or as given in the quantities. If any soft places are found in the bed ground, they shall be thoroughly wetted and well panned, and if necessary an extra thickness of concrete shall be placed in them at schedule rates to the satisfaction of the surveyor.

Concrete.—The concrete shall be composed by measure of 4½ parts of clean broken stone *to pass through a* 1¾*-inch ring*, 1½ parts of sand, and 1 part of cement. These shall be gauged in measures, and if hand-made, turned over *twice dry* and *twice wet*, clean water being only *sprinkled* over from an elevated tank until it is of a proper consistency—and it is to be used before setting has commenced, as softening or retempering will not be allowed. The concrete foundation shall be laid by skilled men in one layer of full thickness, and it shall be forthwith brought to the proper cross-section and gradient of the road, and finished off by beating to a good surface. Any hollows afterwards found in the surface shall be made good with cement mortar, in the proportion of 1 of cement to 1½ of sand. No concreting shall be attempted during frosty weather. The concrete alongside the curbs on each side of the carriageway shall be graded for water tables.

Asphalt.—The asphalt shall be Natural Rock Limmer Asphalt, containing 15 per cent. of bitumen from the mines of an approved company, and a block of the asphalt, bearing the stamped imprint of the mines and company, shall be deposited with the surveyor before the contract is settled. It shall be used in the proportion of 56½ per cent. to the whole admixture.

During the process of melting a proportion of 3½ per cent. of natural refined bitumen of the specific gravity of 1·2 (and containing at least 70 per cent. of pure bitumen and 0·3 per cent. of heavy [950 s.g.] shale or mineral oil) shall be added to the asphalt. The resulting mixture shall have incorporated in it 40 per cent. of dry *screened* Dalbeattie ⅜-inch granite chippings, free from dust; the asphalt and bitumen to be melted and thoroughly amalgamated with the chippings in a combined cauldron and mixing machine, continuously agitated by mechanical power.

The mixed granited asphalt shall be laid by skilled men, of such a depth as will give a finished thickness throughout its whole area of at least 1½ inch after rolling on the carriageways and passages, and 1 inch on the footpaths; the finished surfaces shall be formed to proper gradients, and the camber or cross fall from centre of roadway to each channel shall be to a true curve, at the maximum rate of 1 inch to every 3 feet of width. At all joints, and along each side of the carriageway, there shall be an underlayer of fine asphalt.

When the hot granited asphalt has been laid on the concrete, and before it has cooled it shall be sprinkled with Dalbeattie granite dust, raised to a temperature of at least 200° F., and then be finished off by rolling with suit-

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able rollers for indenting the surface. When completed, and with the consent of the surveyor first obtained in each instance, the finished portions of the pavement shall be opened for traffic in suitable lengths or widths during the further progress of the works.

Plant.—The contractor may use the roadways for placing thereon stone breakers, engines, mixers, screens, and materials, together with any other machinery which is necessary for the execution of the works included in this contract, but in all cases with the consent of the surveyor first obtained. Such materials, plant, and stores shall, from time to time, be moved as the work progresses, and, if directed by the surveyor, it shall, at any time, be removed from the works.

Notwithstanding, the permission of the Council, as contained in the preceding paragraphs, the contractor shall and will, by the signing of the contract, indemnify the Council against any action for damages or nuisances to person or property caused by the use of machinery, or the storage of materials, or otherwise, during the execution of the works in the contract.

Conveniences.—The contractor shall, at his own expense, provide proper and portable conveniences for the use of the men, and shall, at all times, keep the same clean and in a proper sanitary condition; the Council's sanitary department undertake only the removal of excreta, by arrangement.

General.—Other work, not herein specified or comprised in the schedule, and usually done by local contractors in private streets works, shall be done by the contractor at the discretion of the surveyor, as part of his contract, at usual rates.

Contract.—The contractor will find sureties for and enter into the Council's usual form and terms of contract and bond for asphalt pavements.

Note.—The specification will, in every detail, be strictly enforced, and contractors tendering must provide for this.

The following table shows the extent to which the pavement has been laid in Stretford since it was introduced late in 1904.

Year ending.	Total cost.	Average cost per square yard.		
		Carriageway.	Footpath.	Passages.
	£ s. d.	s. d.	s. d.	s. d.
December, 1905	5,672 14 8	9 8	4 9	6 6
„ 1906	4,257 10 2	8 10	4 9	—
„ 1907	19,976 14 9	8 4	4 9	7 4
„ 1908	6,252 5 5	8 3	4 9	7 6
„ 1909	2,160 11 1	8 5	4 8	7 6
„ 1910	5,181 8 0	6 3½	4 1	6 6½
„ 1911	5,385 17 2	6 1	3 11	5 10
„ 1912	7,970 9 11	6 9	4 8	6 0
(In hand) 1913	18,343 0 0	—	—	—
	£75,200 11 2			

The average price for passages in 1910 (6*s.* 6½*d.*) does not include a batch of passages in Trafford Park which, being on a peaty bed, were given a special (8 inches) foundation. The price for these was 8*s.* 3*d.* a square yard.

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Besides the above the following paths have also been paved in the public parks, with ¾ inch of asphalte on 3 inches of concrete—

In 1906, Hullard and Victoria Parks, £951 8*s*. 5*d*., 3*s*. 11*d*. per yard.
In 1907 „ „ „ £1590 12*s*. 6*d*., 4*s*. 4½*d*. „

making a total outlay on the work in Stretford of near 78,000*l*.

The foregoing list represents a total of one hundred front streets and fifty-six back streets or passages, which latter include many groups of passages.

The average cost in each year of the items of asphalt and concrete in the carriageways and paths respectively, shows a fairly gradual reduction. This is attributed to growing competition for the work; local contractors who viewed the innovation with distrust have realised that the pavement has come to stay, and they must equip themselves for it or be left behind. The first law: self-preservation, has asserted itself. The higher prices last year are due to the increased cost of cement and other materials and labour generally. The average price of the past three years, 6*s*. 3½*d*. and 4*s*. 2*d*. a super yard for the asphalt and concrete in the carriageway and paths respectively, gives a rate per lineal yard in a 36-foot street of 3*l*. 2*s*. 1*d*. This, compared with Lancashire setts and flags at 6*s*. 6*d*. a super yard, shows an advantage of 11*s*. 7*d*. in favour of asphalt per lineal yard of street, that is 1*s*. 11*d*. per foot frontage. The other items common to private streets works —excavation, adjusting surface drains and gullies, etc., are similar in each case, and so do not affect a comparison. To return to the process of the work itself. The underbed having been formed to falls and contour the concreting presents no especial feature, usual care being taken to ensure that only good cement, sand, and aggregate are used. We formerly admitted brickbats, but now require all-stone aggregate which gives cleaner and harder concrete. This is brought to its finished surface without rendering by a travelling screed which runs on wheels over graded strips laid on the kerbs. A constant difficulty is to prevent the men using too much water—a soft mixture makes less tax on their latent strength. The concrete in ordinary cases is laid 6 inches in thickness in the carriageways, 4½ inches in the passages, and 3 inches in the footpaths, and we require a week for setting before doing further work on it.

A 6-inch bed of concrete is also laid for the 9-inch by 6-inch granite edgings which are used at the street ends, or wherever the asphalt will not finish against asphalt previously laid or curbs. We have found it essential for the asphalt to be finished at the edges against a rigid material immovable under traffic or wear, otherwise vibration shatters the loose edge over a gradually increasing area. This has occurred especially at hinged manhole covers and paved crossings. The latter is now obviated by using granite edgings laid flush with the surface, and an improved iron cover with the frame continued round the hinges has been adopted. The edgings cost, delivered on rail at Stretford, 3*s*. 10*d*. a lineal yard, and the covers weighing 3¾ cwts., cost 21*s*. each. The asphalt blocks are broken and thrown into a heated cauldron, in shape like a large tar boiler, but with gear attachments driven by a portable engine and rotating an axial shaft with arms on it for continuously agitating the contents. In a large street or group of streets, three or four of these mixing machines are driven from one engine, thus giving a

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rotation of boilings for the asphalter laying the material, without a long wait between. The amount of rock and other ingredients thrown into the cauldron depends upon the size of the machine, which varies from two to seven tons capacity. A 3½ per cent. flux of Trinidad bitumen and oil as described in the specification is added early in the melting process, and later, all by weight, 40 per cent. of dry screened granite chippings. The moisture in the granite is first evaporated on a dry hearth. The following table gives in cwts. the proportion of the three ingredients in boilings of from two to seven tons:—

Capacity of cauldron.	Rock asphalt 56·5 per cent.	Bitumen flux 3·5 per cent.	Granite chippings 40 per cent.
40	22·60	1·40	16·00
50	28·25	1·75	20·00
60	33·90	2·10	24·00
70	39·55	2·45	28·00
80	45·20	2·80	32·00
90	50·85	3·15	36·00
100	56·50	3·50	40·00
110	62·15	3·85	44·00
120	67·80	4·20	48·00
130	73·45	4·55	52·00
140	79·10	4·90	56·00

The whole admixture is kept in motion during the melting process which drives off all remaining moisture, and after boiling at a temperature of round 300° Fahr. the "boil" is ready for laying. The boiler man must understand his responsibility and be quite reliable. Any carelessness or incompetency on his part will spoil the mixture. He is responsible for the proportioning of the ingredients and the temperature and period of the boiling. A material variation in either makes the asphalt either hard and brittle or too soft. The desired medium is just sufficient ductility to prevent cracking and to receive only mild impressions which roll out under wheeled traffic. The boiling complete, the asphalt is drawn from the cauldron into strong buckets placed on a flat waggon and run on light rails to the asphalter. His labourer empties the hot mixture where it is to be laid, and it is then floated on the concrete bed to the specified thickness. Either dry granite dust or cement is dusted over the surface to prevent adhesion to the wood float, and the asphalters are followed up by the roller-man who, while the material is hot, indents the surface with a notched brass roller 18 inches long by 4 inches in diameter, and weighing some 50 lbs. attached to a long arm. The object of this indenting is not chiefly as is commonly inferred to improve the foothold, but rather, like the stippling of a painted wall or ceiling, to break the waviness of a large unbroken surface. The indentations eventually roll out under wheeled traffic, but the waviness that would show badly on a new surface is not then so apparent.

Some merits claimed for the pavement are its quietness as compared with setts; its sanitary qualities—being non-absorbent, impervious, easy to clean, and nearly jointless; its easy and safe traction due to the small camber needed; its easy scavenging, low maintenance cost and its durability. Noting

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these properties briefly in order; its comparative quietness and cleanliness are perhaps self-evident. The Author's residence is at a junction of roads paved respectively with setts and asphalt, and the passage of vehicles from one to the other resembles the stopping of a resonant clock in the dead of night. Its cleanliness is due to the absence of joints. The only dirt it holds is that carried on to it; and the imperviousness of bituminous asphalt contrasted with a macadam, a gravel, or a sett-paved street, in which latter the joints represent from one-eighth to one-fourth of the whole surface, is obviously marked. The tractive effort for similar loads on a smooth as compared with a roughly paved surface must be considerably less, due to the reduced friction and resistance. This phase of the question would repay systematic investigation. The reduced wear-and-tear alike on animals and vehicles could it be given in figures would show a considerable gain to the team-owner.

These gentlemen at first opposed its adoption. If a horse fell on asphalt the pavement was to blame; if it fell elsewhere it was inevitable. An Inspector of the Local Government Board was impressed with this view when, after a local inquiry, in visiting the sites of the works concerned, we saw a team recumbent on a sett pavement. That opposition has long disappeared, and main traffic routes now change where feasible to the asphalted roads. The small camber ensures a distribution of wheeled traffic over a greater width of the road than where the cross fall is acute, and the "tracking" which is the bane of macadam roads is unknown. The foothold is good on probably a greater number of days in the year than is the case on setts and macadam. Certain climatic conditions affect every type of pavement, and asphalt is at its worst when a frost quickly follows rain or a very humid atmosphere. The slipperiness then experienced lasts only a short time, for the non-absorbent and non-conducting properties of asphalt offer a poor habitat for frost. The easy scavenging of the pavement is at once a sanitary and an economic advantage. We find an "orderly" service sufficient, allocating to a man with a handcart an area that can be covered each alternate day. Five such men so scavenge all the asphalt streets we have, and fewer would serve were the streets not so scattered as to take up time in reaching them. Including this each man keeps clean some 30,000 super yards of pavement. Less frequent scavenging is unsatisfactory as the unbroken surface readily displays any dirt on it and thus compels attention. Maintenance cost and durability are practically one and the same question. Nothing so far has been paid for repair in any of these streets, apart from the incidence of covers and curbs previously mentioned.

In the first five or six years our contracts provided for ten years' free maintenance by the contractor; the maintenance period in contracts has now been reduced to five years. The firm who did our first work offered that longer period, and the assurance it gave of their own faith in the material was no small inducement to its adoption by the Council. After five years' experience the Council were satisfied as to the durability of the material, and they then reduced the period of guarantee, as stated. This induced freer competition, and enabled smaller firms to undertake the work.

The evidence so far gleaned of the probable useful life of the pavement suggests that it will be longer than that of sandstone setts. The first street

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we laid has now been down nine years, and there is no apparent deterioration of its general condition. This longevity may be attributed mainly to two of the properties of asphalt; its ductility and the stability of its chief ingredient, bitumen. Its plastic nature ensures the absence of attritive wear, the traffic apparently only compressing it. Sections of the material taken up after many years wear show the slight reduction of thickness to be due to compression, and not to abrasion. Bitumen, unlike tar and its derivatives, is almost non-volatile, and retains its plastic property for an indefinite period, hence there is good reason to suppose that its life will be a long one.

A feature of the pavement which materially affects its useful life is that, even when the veneer of asphalt is spent, if the concrete is good, the foundation is permanent, and improves with the lapse of time, and the veneer can be renewed again and again, as may be necessary. The pavement is not without some faults, and those we have experienced may perhaps be noted with advantage. Should any of you introduce it to your district you will probably find that the bad inch will excite more comment than the good mile. Human nature seems to be so constituted as to magnify the smallest speck on even the finest landscape.

Occasional lateral fissures, chiefly in the carriageways, are so far an incurable flaw. They look bad, although they are seldom wide enough to admit the blade of a knife. They puzzled us for a time, but they were eventually traced to a small shrinkage of the foundation. This shrinkage is perhaps not surprising, in view of the large unbroken area over which the concrete is laid, and at present we see no cure for it. It is also difficult to repair, the fissure being so fine as not to admit any grout, and to cut out and patch the joint seems to make two joints where only one existed before.

Another flaw is an occasional surface swelling of from 2 to 3 inches in diameter by ½ inch high, invariably in the paths. This appears to be due either to an unslaked particle of lime in the cement swelling and forcing up the asphalt, or to imprisoned moisture swelling after frost. The fact that it appears with little exception in the paths, as distinct from the carriageway, suggests that the stronger section of the latter offers too much resistance to the upward force of the swollen particle of lime or moisture.

Defects due to the human equation have also to be considered. The disinterested, careless, or lazy workman is everywhere to be found, and he leaves his trail behind him. He eludes the most thorough and conscientious supervision. Bad patches in the asphalt have been taken up, and chips of barrel wood found in the material. Other decayed spots have been due to burnt asphalt. Either of these flaws in the pavement will offer warrant for the croaker to say that the pavement is breaking up, and is a costly failure, etc., *ad libitum.*

Defects which appear to have developed after the pavement is matured, have been traced to devotees of Guy Fawkes, also to the thoughtless tradesman when laying gas or water services placing his movable fire on the pavement. A material which is moulded by fire obviously cannot be expected to resist the temperature which produced it. The solar heat in this country has little or no effect on it.

Authority for the use of asphalt in private streets works is given in section 11 of the Public Health Acts Amendment Act, 1890, and the clause

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applies to procedure under section 150 *et seq.* of the Public Health Act, 1875, under which the Stretford Council operate.

In the earlier years of this work here the opposition of property owners to its use in private streets completion was pronounced, chiefly on account of the higher cost of asphalt over the gritstone pavement to which they had been accustomed. Formal appeals after apportionment were made to the Local Government Board, and in two instances their inspectors held a local inquiry. In the third case the appeal was withdrawn. The grounds of appeal were substantially identical in each case, and evidence was given for the appellants and the Council. The awards directed a rebate in each case of an amount approximating 5 per cent. of the total, which agreed with the aggregate of certain private, as distinct from general, charges in respect of special work on particular frontages. Although the inference to be gleaned from this analogy was understood by the Council, they kept ultra-good faith with the awards by thenceforth making a rebate of 5 per cent. in similar apportionments for asphalt pavements, as a contribution to its cost over setts. The reduction in cost before mentioned brought down the charges to compare evenly with those for sett pavements, and in February, 1911, the rebate was withdrawn.

The subject has, perhaps, carried me beyond the range of a short paper, but it is by no means exhausted. These cursory notes on it have been strung together only as offering some points for discussion. They give in tabloid form our first-hand experience of the work, which represents a local effort to meet the growing demand for a more clean, silent, dustless, economical, and durable pavement than is in common use.

DISCUSSION.

The Chairman said they were all greatly indebted to Mr. Worrall for his most practical papers on road making. They were indebted to Mr. Worrall for his painstaking care in preparing the paper with its very complete details, which could not fail to be of great use to all of them in their daily work.

Mr. Stubbs (Blackburn) said he was sure their thanks were due to Mr. Worrall. He had some little experience of that class of road; in fact he had constructed two long streets on a gradient, but his experience had not been quite satisfactory. They did two streets with asphalt as an experiment around one of their large schools. It was a street where the traffic was light, indeed, but the material proved too slippery. In a town like his the horses were shod differently to those in Stretford; they had large coblets and toe pieces on, and the horses were likely to slip on asphalt. For wear and tear it would no doubt be satisfactory. He was surprised to hear the cost was more than the ordinary price was. His experience was that the granite street cost more than the ordinary pavement. As far as scavenging and wear and tear were concerned, there was no doubt that a better street could not be found. They had an advantage in Stretford that the district was flat. The road where they had put it down was about 1 in 140, and he would hesitate before he put another down on that gradient. The figures Mr. Worrall had given had also worked out to his own setting. The firm who did his work came from the Manchester district, and they put $1\frac{1}{4}$ inch

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on the top of concrete, and he had no doubt it would be a useful street yet. But they couldn't drive a horse used to stone setts on a smooth asphalt road or smooth surface; it would go down.

Mr. Councillor J. Swarbrick (Manchester), like Mr. Stubbs, had seen two sides of the asphalt question. He was old enough to remember when the Manchester Corporation laid the first length of asphalt in York Street, Manchester. They laid it in a comparatively narrow thoroughfare, it had little opportunity of getting thoroughly dry, and in the humid atmosphere of Manchester, with its heavy traffic, and horses accustomed to going over granite sett pavements, asphalt of that kind was not a success. It was largely due to its being unsuitable to the traffic in that particular part of Manchester. Unfortunately it created such an enormous amount of prejudice against it, that until a few years ago the Manchester Corporation never dared try it again. He could not say tar macadam was altogether a success at Withington, but in some cases it was successful. In other instances rock asphalt was laid with satisfaction, and he believed it was the pavement of the future for suburban areas.

Mr. Price (Lytham) said he thought it very probable that with the experience they had had in the past year they would want to adopt something else than tar macadam. He had laid a fair amount of it with a certain amount of success, but during the past year, owing to the bad weather, and the fact that the tar had not been of the same quality, he had had failure for the first time in fourteen years. It cost roughly on an 18-inch double foundation, and 6-inch tar macadam, about 4*s.* 6*d.*, and if he could get a concrete foundation, and 1½ inch of granited asphalt for a total of 6*s.* 6*d.*, he would have to think seriously whether he wouldn't recommend granited asphalt instead of tar macadam. Tar was going up, and they would have to find another substitute, and, as granited asphalt was coming down, they would have to take into consideration whether they would not have to adopt that. This year had been bad for laying tar macadam, and the failure had not been in one place only. Throughout Lancashire generally there had been large failures.

Mr. Mountain (Barton-on-Irwell) said he had not had a great experience of asphalt, but had had considerable experience of tar macadam. It was tricky material to lay, because, unless the weather was good, they got failure. In that way rock asphalt was better, could be better prepared, and, if laid on a good concrete bed, he had no doubt it was far superior to tar macadam.

Mr. Stubbs (Blackburn) said it might be found that a concrete bed under a granite pavement was a success, but he had found it to be a failure. His town turned out tremendously large boilers, which had to go over their streets. In one street he made, he put 6 inches of concrete and setts on top, and before it had been down five years the setts were crushed and practically made into macadam. The next street he pitched and filled up with ordinary broken stone, rolled well in, and they had not had a broken sett on it for years. It seemed strong and pliable. The question of asphalt macadam had not been touched on. It made good roads if they got suitable weather. He got tired with the last length he laid; to get half of 100 yards done took seven weeks. He was so disgusted with it that he stopped the work, and did the remaining portion with rocmac. It had been down side by side for over

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four years, and the rocmac was wearing better, and the weather had no effect on it. He strongly recommended it for trial.

Mr. Saville (Darwen) said where they got rapid traffic, especially heavy motor lorries, it crushed granite setts. In cases where the road was consolidated, like macadamised roads, they did not get excessive concussion, and that road was necessary for the new type of traffic with excessive vibration. With regard to tar macadam, he had put it down for five years, and it had worked well. There was a great difficulty in laying it in wet weather, especially the weather they got in north-east Lancashire. He had had great difficulty in getting repairs executed because of the wet. He had tried rocmac, and it had worked well with heavy traffic. It was a more handy form of construction than tar macadam, and much cheaper.

The Chairman: Have you found any limit to gradient with regard to tar macadam?

Mr. Saville: Yes; I do not lay it down where the gradient is more than 1 in 20.

Mr. Statham (Salford) said they had followed Stretford's lead, and had recently done a considerable amount of work with rock asphalt. He was particularly interested in Mr. Worrall's paper, and his figures worked out to within half a penny of the cost of work in Salford. With regard to the difficulties, he could bear out what Mr. Worrall said; there must be an unyielding surface. They had one or two cases, such as the edge of crossings, where trouble had arisen. If the setts were not properly backed up against the edge, and gave at all, the asphalt gave with it and was likely to chip. They had not yet used it on the footpaths, and had not had the difficulty of blistering.

Mr. Robinson (Chairman of Stretford U. D. C.) was invited to give an opinion on the subject. Mr. Worrall, he said, had expressed the collective view of the Stretford Council. From the point of view of a sanitary street, he thought the construction was ideal, it was watertight, easily cleaned, and very silent. There was one disadvantage, it was slippery, especially if a keen frost followed rain. It would be a wonderful thing, however, if it had many advantages without one disadvantage. Years ago frontagers objected to roads completed in rock asphalt on account of expense, at that time the cost was very high. To-day the cost was much lower, and for some time he had not heard of any complaints by frontagers. The Stretford Council was tired of macadam roads, they were filthy, unsanitary, and everything that was bad; cleansing costs were enormous.

Mr. Cunliffe (Withington) said he had had quite a wide experience in connection with roads of this class, and he had looked upon Mr. Worrall as the leading man in this kind of paving, and he had always had a great opinion of him for taking greater risks than he himself would care to run in going forward with this kind of pavement. From his experience it was the best kind of road he knew. One might put down tar macadam for a dozen streets and make good roads, and with the next one, with no fault in the making of it, get a bad road. Mr. Worrall's paper had covered everything in connection with asphalt. All the disadvantages Mr. Worrall had found in connection with the paving, he had found also, but the advantages appealed to every one. The method of apportioning the material was in a doubtful state, and he

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wondered if Mr. Worrall had taken any particular precaution in testing the proportion of material. Had he ever noticed that the material deteriorated in quality? They believed that asphalt was an imperishable substance, but it appeared to him that when it had been down for some time it deteriorated; some of the oil seemed to evaporate. They reduced their specifications in Withington, and when they put more asphalt and less granite they got a softer material, but then they got complaints that when horses and carts stood at street corners for some time in the summer the horses stuck to the road. It was only in a hot summer they noticed that. Did Mr. Worrall think the material did dry up, and if in fifteen years the roads would break to pieces because there would be nothing to hold them together?

Mr. Swarbrick, referring to Mr. Robinson's remarks on the dust nuisance of macadam, said that Mr. Royle, who used to be surveyor at Stretford, made some interesting experiments more than forty years ago. In one of the earliest volumes of the Institution there appeared a paper by Mr. Royle, in which he pointed out that the cost of scavenging on macadam in Manchester varied from five to seven times as much as the cost of scavenging on a granite-paved road. He stated definitely that one might take the average to be five times as much.

Mr. T. West (Stretford), who said he had been employed by the Stretford Council for twenty-one years, gave the horsekeepers' views of rock asphalt. In November, 1909, they had a heavy frost for about three weeks, which got three or four feet into the ground. It did not get through the rock asphalt, and the horse drivers said they would rather go 20 miles on rock asphalt streets than 1 mile on ordinary macadam road.

The Chairman proposed a hearty vote of thanks to the Author of the paper. He had not had any experience himself in laying granited asphalt; they at Blackpool were very keen on wood pavements. The chief reason for that was that it was noiseless, or nearly so. He had known of Stretford by repute for some years as being absolutely the headquarters of granited asphalt pavement, and as affording a remarkable example of all classes of pavement at once reasonably cheap and most efficient as regards sanitary requirements. He would like to know whether Mr. Worrall had the traffic statistics with regard to the amount of traffic on his roads. He would also like to learn as to the gradient Mr. Worrall considered fairly safe for this class of pavement. What description of granite did he use in the mixture? There were granites and granites, and, unless one exercised particular attention to the granite, trouble might arise. Mr. Worrall told them he had five years' guarantee. He had five years on all his street works, but he thought it was troublesome to work out, and about the second or third year the contractor came to them and said he was quite sure the work was going to last five years, and wished they would hand over the retention money. Retention money might be very necessary to the small contractor. How did Mr. Worrall get on with the natural-born enemy—the gas, electric, and water engineers? How did he patch up when those road depredators had done their work? Was the expense considerable, and had he any complaints of the excessive expenses they were put to in making up the roads? He had not gathered whether Mr. Worrall had occasion to put gritting of any kind on the streets at slippery times. He could not help thinking that Mr. Worrall's success had been

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largely due to the fact that he had bred, so to speak, a good class of contractors for the work. His costs gradually came down. He had drilled his contractors so thoroughly in the last eight or nine years that they were beginning to thoroughly understand their work. It was a great boon to surveyors to get contractors who would honestly carry out their work.

Mr. Stubbs formally seconded, and the motion was carried with applause.

Mr. Worrall, in returning thanks, said he could not disclaim any special knowledge or experience of the subject, since the burden of his paper was that they in Stretford had had unique experience in laying rock asphalt pavement. Mr. Stubbs referred to the slipperiness of the pavement. In Stretford they had not had an opportunity of laying it at a steeper gradient than 1 in 30 or 40, except on main roads, which were paved with granite setts. At the time they were about to repave the main roads they were considering the rock asphalt pavement, but they were then practically through their negotiations for the work, and the macadam road was relaid with setts on a concrete bed. As regards the necessity for gritting; they did occasionally in the winter months grit these pavements when frost held sway. They used cinders, primarily because there were unlimited supplies in the district, and they served the purpose quite well. With reference to cost, he gave the figures in his paper for that district, where, doubtless, the freight on materials was a little heavier than in Blackburn. He also gave the comparative cost as against granite setts and flags, which showed a saving to street frontagers of 1*s.* 11*d.* per lineal foot frontage. They had had experience of rocmac in Stretford, and had no prejudice in the matter when they adopted rock asphalt. Rocmac had done fairly well in the limited quantity they had felt justified in laying. It was in a narrow street in the "village" end of the district, and they laid 400 or 500 lineal yards. At first it appeared to be good, and no doubt was a vast improvement on the old macadam, but its durability had not proved so good as they now expected from rock asphalt. The rocmac pavement they laid four years ago had to be crowned again two years later, as it worked into holes, like an ordinary macadam road. Relatively, its cost would be greater than rock asphalt. It required topping in two years, and parts wanted doing again. There had been no additional cost in the rock asphalt pavements, except where there were faults of workmen, and where foreign ingredients had found their way into the material. Replying to Mr. Swarbrick, Mr. Worrall said the asphalt laid in York Street, Manchester, would be the compressed asphalt with which they were familiar in London. London horses were shod differently to Lancashire horses, and they could negotiate it better. Some seven or eight years ago they had occasion to repave their main road at a cost of from 16,000*l.* to 17,000*l.*, and, without going into the whole subject, they felt confident in recommending the county to allow them to relay the roads with concrete foundations. This experience had justified it, and he was pleased to see Manchester found it so good as to introduce it into the city. There was no doubt about it that the economy in scavenging gained by rock asphalt would be a strong argument in its favour. All the rock asphalt streets in the Stretford district were scavenged by five men, who did each street on alternate days. Then one must have regard, in considering the cost of scavenging, to the efficiency of scavenging. They must scavenge asphalt streets well, or they looked very bad indeed; they

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could not be done like ordinary roads. Mr. Price had referred to his unfavourable experience of tar macadam in Lytham. He had heard Mr. Price claim great things for tar macadam in Lytham, but he frankly admitted it was previous experience to last year. The question of the weather raised a big advantage for rock asphalt in preference to tar macadam. It was an advantage to lay rock asphalt when it was dry; but it was not essential. If there was any surface wetness, he found it an advantage to sprinkle cement over and brush it off again. The visible effect of asphalt over a damp surface was that wet bubbles were caused. Mr. Stubbs also referred to the defects of concrete foundation under granite setts. He (the speaker) did not think there was a district in Lancashire with heavier traffic than the Old Trafford area. It was the main district for the docks, and it was not uncommon to have 50 to 80 tons going over the road to the docks, and they certainly had not experienced that disadvantage. As regards the kind of setts used, the Council had pinned its faith to Penmaenmawr granite. Mr. Statham had confirmed what he (the speaker) stated in his paper with regard to the absolute necessity of having an unyielding finish to the work. Mr. Cunliffe had referred to the difficulty in the proportioning of ingredients. The table of proportions given in the paper was for reference, as it gave the correct proportions for each size boiler from 2 to 7 tons, and all the proportioning was done by weight. Replying to the Chairman, Mr. Worrall said he happened to come to Stretford at the time when the Council was considering the question of private street completion. Tar-paving had been tried, and did not appear to be satisfactory, and he suggested and was instructed to investigate the rock asphalt system. They experimented with it, and their initial beliefs had been justified by results. With regard to the contractor's guarantee, perhaps in this connection it was a good thing. The choice of contractors was somewhat limited, because it wanted a man with capital, plant, and substance to undertake work of this character even now. With long usage and wider range they still preferred to have men of substance, because they reasonably expected they would get better results, and, as a rule, they were more careful men in their work, as they had a reputation to lose, and were anxious to retain their trade name. The method of opening a trench was to cut the asphalt 2 or 3 inches wider than the concrete, and the heated asphalt seared into the asphalt already laid, and made, for the time being, an almost undetected joint. They found sometimes it was not a permanent joint. That might possibly be due to the contraction of the concrete, or to the contraction of the material in cooling; but the fissure left was not wide enough to insert a knife blade, and was so small that it could not be filled. It was strange how one was apt to magnify two or three such joints in a whole street, and yet look with calm contemplation on a new sett road where the joints varied from one-eighth to a fourth of the whole surface. He also had thought he might find trouble from the action of frost, but so far he had not experienced that. Those answers, he thought, covered substantially the various points raised. The Chairman of his Council had referred to the question of dust and diphtheria, and while they did not specifically claim that the very low death rate of the district was due to the large area of asphalt-paved streets, he thought it was possible there might be some relationship. Stretford enjoyed last year the remarkably low death rate of 11·2, which compared even

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with Blackpool, Lytham, or any of the other delightful watering places from which Members came that day. The sanitary value of the asphalt street was a point which should not be overlooked.

THE CHAIRMAN announced that the next district meeting would be held at Rochdale.

This concluded the business, and the Members paid a visit of inspection to rock-asphalted streets in Old Trafford, to the Public Baths, Seymour Park Schools, and the Technical Institute.

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NORTHAM OPEN-AIR BATH, CONSTRUCTED IN FERRO-CONCRETE.

A Paper read by Mr. J. A. Crowther (Member) at a Meeting of the Southern District, held at Southampton on Saturday, February 22, 1913.

THE original bath, which was constructed some years before the writer of this paper came to the town, was presented to the Southampton Corporation by Tankerville Chamberlayne, Esq., Member of Parliament for the Borough. The bath was originally 156 feet by 30 feet, having a depth of 6 feet. The ground proved to be very treacherous, which will be readily understood on reference to sections showing the borings. It will be seen that two forces must be provided for.

1. When the tide is out and the bath full of water.
2. When the tide is high and the bath empty.

The Itchen is a tidal river and the bath was and is filled by the rising tide. To meet the requirements of Clause 2, it is evident that the bath must be securely anchored to the bed of the river to ensure it remaining in position when the bath is empty and a high tide prevailing, otherwise the bath might go sailing gaily down the river possibly to the detriment of shipping. Soon after the old bath was brought into use cracks in the walls and floor developed, and to such an extent, that it was found to be impossible to keep the water in the bath when the tide was out. Tests were made by closing the inlet valve and allowing the tide to rise outside. The result was, that as the tide rose, a distinct tremor could be felt by any person standing on the edge of the bath. Again, wooden wedges loosely inserted at low water and with the inlet valve closed, could not be withdrawn by hand when the tide had risen. Under the above circumstances the Author could not advise the Town Council that it would be safe to use the bath even when there was sufficient water in the same.

In February, 1903, the Author submitted two schemes to the Baths Committee for reconstructing the bath, and bearing in mind the two forces previously referred to, the Author has endeavoured to provide for the same.

Scheme I. was for ordinary elm piles with a concrete superstructure.

Scheme II. was for ordinary ferro-concrete, Hennebique system, throughout.

The estimate for scheme I. was 1069*l*., and that for scheme II. 970*l*., and as the difference in the estimated cost was so small the Author advised the Town Council to accept scheme II. (being now, from a variety of causes, distinctly of opinion that ferro-concrete work will last as long or longer than

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ordinary timber piling). On account of expense and obtaining better foundations, it was decided to construct the new bath of less dimensions than the first one, this was obtained by curtailing the projection of the bath into the river (see plan). The dimensions of the new bath are 75 feet by 30 feet, with depth at the deep end of 7 feet, and at the shallow end of 4 feet 6 inches, and filter or straining chamber 30 feet by 10 feet. The greater part of the old bath was removed, but the side walls of the remainder were left so as to provide a promenade for the new part, care being taken to ensure the proper bonding of the old and new work.

Method of construction of the new bath.—The whole bath and filter are carried on 22 ferro-concrete piles, 14 inches by 14 inches by 32 feet long, 5 inches by 10 inches ferro-concrete beams, 4 feet 10 inches centre to centre, laid longitudinally, and 7 inches by 13 inches ferro-concrete cross beams, laid 9 feet 4 inches, centre to centre. The specification provides that in the driving of the piles they must not exceed $\frac{1}{2}$ inch, set with a 30-cwt. monkey, falling 30 inches for the last ten blows. The formula used for calculating the resistance was the usual one of $L = \frac{WH}{8D}$.

Where L = safe load on pile in cwts.
W = weight of monkey in cwts.
H = fall of monkey in inches.
D = set of pile in inches.

The set of every pile was carefully observed, and hereunder will be found a few examples:—

No. of pile.	Length of pile.	Length driven.	Set.
11	32 feet	28 feet 9 inches	$\frac{1}{8}$ inch.
12	32 "	28 " 0 "	$\frac{1}{2}$ "
13	32 "	27 " 6 "	$\frac{1}{2}$ "
14	32 "	26 " 9 "	$\frac{1}{2}$ "

It will be noted from the above table that although the piles were made 32 feet long, the distance driven was from 26 feet 9 inches to 28 feet 9 inches, at which depth we obtained the required resistance. The concrete was then stripped off the projecting portion of the piles and the steel bars bent over and thoroughly interlaced with the horizontal and cross beams. The floor and walls are $4\frac{1}{2}$ inches thick. The concrete walls of the old bath (before referred to as being left as a promenade) are carried on the cross beams which are continued through the heads of the piles and about 15 inches under the old walls. A chase is then cut vertically in the old concrete wall, and the cross beam continued upward on this chase as a counterpart. The steelwork of the whole, the piles, beams, floor, and sides are all tied together and interlaced by means of straps and the main bars, so that the whole is securely bound together. The piles were made in wooden moulds laid horizontally, and each pile was made up of four bars, $1\frac{1}{4}$ inch diameter, running the entire length of the pile, these being braced together with links or stirrups $\frac{3}{16}$ inch diameter. The iron work was first placed in position so as to leave a space of about $1\frac{1}{2}$ inch (not less than 1 inch) between the iron and wood framing, so that the concrete might entirely surround the metal and

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preserve it from the action of sea water, the mould was then filled up and carefully punned so as to make a solid mass.

The piles were turned in about fourteen days, and then left for further drying. When considered sufficiently set or hardened, the piles were placed in an upright position for driving, and in this position the atmosphere could play on all four sides of the pile and so quicken the process of seasoning. While in the vertical position each pile was watered every day before being driven. As it was necessary to complete the work as soon as possible, some piles were made up with an aggregate of 3 to 1, and driven three weeks after being made. These piles showed no signs of fracture. The specification provided that the concrete for piles should have an aggregate of 5 to 1, and that for sides, floor, and beams, 4 to 1. The specification for concrete was very stringent, but as the Members of this Association are accustomed to this class of work, the Author does not propose to enlarge upon that part beyond saying that all the cement was carefully watched and tested for specific gravity, grinding, thoroughly air slacked before being used, tensile strength and tests for expansion; care was also taken to secure a clean aggregate.

The tests for steel were as follows: The steel work used in the ferro-concrete construction shall be that known as Sieman's Martin mild steel, of such quality that a test piece 1½ inch diameter shall be capable of bearing a tensile strain of not less than 32 tons per square inch of sectional area, and the elongation of such a test piece 8 inches in length when subject to such a strain shall not be less than 20 or more than 25 per cent. before fracture, and further that a test piece 1½ inch diameter after being heated to a low cherry red, and cooled in water at a temperature of 80 degrees Fahr., shall be capable of being bent in a press without showing signs of fracture, until the radius of the curve of the inner side of the test piece shall not exceed one and a half times the thickness of the test piece. No welded bars will be allowed to be used in the ferro-concrete work. Well knowing the difficulty of securing good concrete work in tidal waters, and especially so as in Southampton we have to contend with four tides each day, every Member conversant with this class of work will recognise the importance the Author attached to securing (1) a good contractor; (2) a stringent specification both as to workmanship and materials.

The first was secured by adopting the Hennebique system of construction, as this firm insisted upon their work being carried out by licensed contractors, which of course means that none but good experienced men would be employed, and this we secured in Mr. F. Grace, a Southampton contractor. Second, the specification provided that upon the completion of the work the bath was to be charged with water to high-water highest spring tide, and to remain so for at least forty-eight consecutive hours, and to be left completely empty for the same period, and to remain perfectly watertight and sound in every detail under these conditions before the engineer will give his certificate as to final completion, and the contractor shall maintain the bath in such watertight condition for a period of twelve calendar months. Although the contractor experienced great difficulty in doing this, he succeeded and left the bath as specified.

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Road Improvements.

We in Southampton, like many other places, have been compelled to change the construction of our roads so as to meet the requirements of modern traffic. Formerly the roads were constructed either of local gravel or flint. During the past few years we have used granite on the principal roads. Last year we decided to go one better, and have now more than 20,000*l.* worth of work in hand on the system adopted by the Trinidad Lake Asphalt Co.'s system.

The Avenue, completed December, 1911.—3-inch Trinidad Lake asphalt macadam, composed of 66 per cent. Guernsey granite, 25 per cent. of sand, cement, etc., and 9 per cent. of Trinidad Lake bitumen. The Guernsey granite used is graded 50 per cent. 1½-inch, 25 per cent. 1-inch, and 25 per cent. ½-inch. This material is laid at a temperature of 250 degrees, and rolled with a 4-ton roller (part was rolled with a 7-ton roller). A squeegee coat of Trinidad bitumen suitably fluxed is applied to the surface after rolling, and then sprinkled with ¼-inch granite chips. One ton laid and rolled 3 inches thick covers about 7 square yards. The base is thoroughly rolled before the asphalt macadam is laid, and any slurry that may be worked up is removed. The granite, etc., is heated to a temperature of approximately 400 degrees, and the Trinidad Lake bitumen, after refinement, is mixed while all is hot. The asphalt macadam can be conveyed a considerable distance by road, with the aid of motor lorries, from the works without losing much of its heat. The price paid was 5*s.* 2*d.* per yard sup., but now, owing to increase in cost of freight, etc., it is raised to 5*s.* 6*d.* per yard sup., including excavating and carting away of old material. The plant as seen is capable of producing about 60 tons of asphalt macadam per day. Satisfactory work cannot be made in wet weather, the foundation must be thoroughly sound and dry, moreover, the material, granite, sand, etc., must be absolutely dry and free of clay or loam before being mixed with the asphalt, and if this is not attended to, failure must result.

Threefield Lane.—Asphalt macadam has been laid in this thoroughfare, one portion, 2½ inches thick with a 1-inch surface coat of finer graded ingredients. The company guarantee the maintenance of their work for a period of five years without cost to the Corporation.

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23	J. T. Earnshaw. 1893.
51	H. G. Whyatt. 1900.

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Field Work and Instruments. By A. T. Walmisley. (14.)
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Page's Magazine.
Sanitary Record.
Street Railway Journal.
Surveyor and Municipal and County Engineer.
Surveying and Housing World.

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SYLLABUS.

The Institution of Municipal and County Engineers undertake the holding of Examinations, by written papers and *vivâ voce*, in the following subjects:—

Engineering as applied to Municipal work. (Two papers.)
Building Construction and Materials.
Sanitary Science as applied to Towns and Buildings.
Municipal and Local Government Law as relating to the work of Municipal Engineers and Surveyors.

Every candidate who applies for permission to sit for the Examination of the Institution must be at least 22 years of age, and must possess one of the Certificates hereinafter mentioned in each of the following subjects:—

English, including (1) English Composition; (2) English Grammar, including Analysis and Parsing; (3) English History; (4) Geography.

Mathematics, including (1) *Arithmetic*—Vulgar and decimal fractions, proportion, square root, simple and compound interest, profit and loss, percentage, H.C.F. and L.C.M.; (2) *Algebra*—the ordinary rules; fractions; brackets; simple, simultaneous and easy quadratic equations, and problems involving the use of such equations; H.C.F.; L.C.M.; and square root; (3) *Euclid*—the first three books.

List of Certificates which will be accepted as evidence that Candidates possess the necessary qualifications in the various subjects:—

(1) English Composition and (2) English Grammar.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.
University of Wales: Matriculation Examination.

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University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.

University of Tasmania: Senior Public Examination.

Central Welsh Board: Honours, Senior or Junior. Certificate to be endorsed "English Composition," "English Language," and "English Literature."

Oxford Local:
Senior Examination—Honours or Pass.
Junior Examination—Honours or Pass.
Cambridge Local:
Senior Examination—Honours or Pass.
Junior Examination—Honours or Pass.

Certificate for English Language and Literature will be accepted as qualification required in English Composition and English Grammar.

Society of Arts: Advanced stage—First or Second Class, obtained since 1904; Intermediate stage—First Class, obtained since 1904; and the certificates corresponding thereto obtained prior to 1904.

College of Preceptors: First Class (or Senior), Second Class (or Junior), in the Professional Preliminary Examination; First Class (or Senior), Second Class (or Junior), in Certificate Examination.

(3) English History.

University of London: Matriculation Examination.

Victoria University: Preliminary Examination.

University of St. Andrews: Preliminary Examination in Science.

University of Glasgow: Preliminary Examination in Science.

University of Aberdeen: Preliminary Examination in Science.

University of Edinburgh: Preliminary Examination in Science.

University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.

University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.

University of Tasmania: Senior Public Examination.

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Central Welsh Board: Honours, Senior or Junior.

Oxford Local: As for English Composition and English Grammar. Certificate for History will be accepted as qualification required in English History.

Cambridge Local: As for English Composition and English Grammar. Certificate (Senior or Junior) for History, Geography, etc., will be accepted as qualification required in English History and Geography.

Society of Arts: As for English Composition and English Grammar. Certificate for Commercial History and Geography will be accepted as qualification required in English History and Geography.

College of Preceptors: As for English Composition and English Grammar.

(4) Geography.

University of London: Matriculation Examination.

Victoria University: Preliminary Examination.

University of St. Andrews: Preliminary Examination in Science.

University of Glasgow: Preliminary Examination in Science.

University of Aberdeen: Preliminary Examination in Science.

University of Edinburgh: Preliminary Examination in Science.

University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.

University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.

University of Tasmania: Senior Public Examination.

Central Welsh Board: Honours, Senior or Junior.

Oxford Local: As for English Composition and English Grammar.

Cambridge Local: As for English History.

Society of Arts: As for English History.

College of Preceptors: As for English Composition and English Grammar.

Mathematics.

University of London: Matriculation Examination.

Victoria University: Preliminary Examination.

University of St. Andrews: Preliminary Examination in Science.

University of Glasgow: Preliminary Examination in Science.

University of Aberdeen: Preliminary Examination in Science.

University of Edinburgh: Preliminary Examination in Science.

University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.

University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

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University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.

University of Tasmania: Senior Public Examination.

Central Welsh Board: Honours, Senior or Junior. Certificate to be endorsed "Arithmetic," "Algebra," and "Geometry."

Oxford Local: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic" and "Mathematics."

Cambridge Local: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic" and "Mathematics."

College of Preceptors: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic," "Algebra," and "Geometry."

Board of Education: Science Examination—Stage 1, First Class; or Stages 2 and 3, any Class.

A Candidate who has been admitted to any of the undermentioned examinations is exempt from further educational examination: The Institution of Civil Engineers, Studentship; The Royal Institute of British Architects, Preliminary; the Surveyors' Institution, Preliminary.

The Council reserve power to alter or add to the foregoing requirements.

No exemption from any part of the examination is granted.

Two or more Examinations are held in each year, one at least, in April, in London, and one at least, in October, in some provincial town to be fixed on by the Council and duly advertised beforehand.

Examinations will also be held in Scotland and Ireland, and in India and South Africa, providing a sufficient number of Candidates desire to enter. Inquiries as to the respective Colonial Examinations should be addressed to A. F. Henderson, Municipal Engineer, Chittagong, Eastern Bengal; or T. W. Stainthorpe, P.W.D., Irrigation Dept., P.O. Box 399, Pretoria, Transvaal, South Africa.

Candidates must in the first place apply to the Council, on the form issued with the syllabus, for "permission to sit."

If permission is granted by the Council, a "sitting" form will be forwarded. The candidate may then, or at any time subsequently, make application on such form to be entered for examination.

The Council will accept entries, in order of priority, as far as accommodation will permit.

The fee for home Examinations is *4l. 4s.*, two guineas to be paid

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when sending in the "sitting" form, and two guineas on the day of examination.

The fee for Colonial Examinations is 4*l.* 4*s.*, to be paid when sending in the "sitting" form.

The fee is to be sent with the sitting form ONLY.

Candidates who do not present themselves for examination forfeit their entrance fee.

Successful candidates receive a "Testamur," signed by the acting Examiners, and sealed and counter-signed by the President and Secretary of the Institution in Council.

A candidate sitting for examination and failing to satisfy the examiners in not more than two of the five subjects, will be permitted to sit at any subsequent examination, on payment of half-fees, for re-examination in the subject or subjects in which he failed. Upon completing his passes in all the five subjects, he will be duly granted the testamur of the Institution.

A candidate failing in more than two subjects will be permitted to sit, for re-examination in all the subjects, at any subsequent examination, on payment of half-fees.

Candidates who have sat and failed, are particularly requested to ask for a "sitting" form, when they desire to enter their names for re-examination.

Candidates who have been relegated in one or two subjects should apply for a "relegated candidate's sitting form" when they desire to enter their names for re-examination.

The Examinations occupy three days, and the subjects are taken as follows:—

First day,	10 to 1 ..	..	Sanitary Science.
"	2.30 to 6.30	..	Building Construction.
Second day,	10 to 1 ..	..	Engineering (1st Paper).
"	2.30 to 6	..	" (2nd ").
Third day,	9.30 to 11.30	..	Municipal and Local Government Law.
"	12	..	*Vivâ voce* Examination.

The questions in each subject are divided into sections, as shown under "Subjects of Examination."

Candidates at home examinations may elect to be examined in either English, Scottish, Irish, or Metropolitan Law. Colonial Law or English Law may be taken at Colonial Examinations.

Candidates must attempt one question in each section, but must not attempt more than six questions in each subject. In the case of Municipal Law, which is not divided into sections, not less than four questions must be attempted. There is no *vivâ voce* examination in Municipal Law.

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The *vivâ voce* examination of Relegated and Colonial candidates takes place during the course of the written papers.

No information as to the result of an Examination, beyond the fact of a candidate having "Passed" or "Failed," or having been "Relegated," is given.

Questions set at Examinations held prior to 1902 can only be obtained in the volumes of the "Proceedings." On sale by Messrs. E. & F. N. Spon, Ltd., Publishers, 57 Haymarket, S.W. The questions set at subsequent examinations are not published.

Any inquiries referring to the Examinations should be directed to Mr. Thomas Cole, Secretary to the Institution, 92 Victoria Street, London, S.W., and should be accompanied by an addressed foolscap envelope.

SUBJECTS OF EXAMINATION.

I.—Engineering as applied to Municipal Work: 1st Paper:

A. Sewage Disposal.
B. Tramways Construction.
C. Bridge Construction.
D. Water Supply.

II.—Engineering as applied to Municipal Work: 2nd Paper:

A. Geodesy.
B. Hydraulics.
C. Sewerage.
D. Road Construction and Maintenance.

III.—Building Construction: Strength of Materials:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building By-laws.
D. Public Baths and Hospitals.

IV.—Sanitary Science as applied to Towns and Buildings:

A. Heating and Ventilation.
B. Scavenging and Disposal of Refuse.
C. Water Supply and Drainage of Buildings.
D. Disinfection.

V.—Municipal and Local Government Law as relating to the Work of Municipal Engineers and Surveyors.

Note.—The Examiners do not recommend any particular text-books, as it is desired to make the Examinations rather a test of the candidate's practical knowledge of the subjects generally, than to find his acquaintance with any particular book or books.

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EXAMPLES OF QUESTIONS.

The following questions have been compiled from Examination Papers set to Candidates, and serve as examples of the questions asked under the different sections.

DIRECTIONS.—"You are particularly requested to write legibly, and to answer the questions as concisely as possible. *Fill in your number where indicated, also at the top of every book handed in. Prefix the number of the question to each answer. Place this question-paper inside your book before handing it in.* Wherever possible, freehand sketches or diagrams should be drawn to illustrate the answer; these should be carefully executed, as they will be taken as showing the Candidate's proficiency in this style of drawing. Candidates must not, during the examination, refer to any books or manuscript, or communicate with each other. Slide rules may not be used."

I. SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

(Candidates must attempt one question in each section, but not more than six in all.)

FIRST PAPER.

(*Time allowed, 3 hours.*)

SECTION A. SEWAGE DISPOSAL.

1. Describe briefly the various systems of treatment now in use at outfall works; explain their general principles, advantages, and disadvantages.
2. Describe an up-to-date system of sewage disposal suitable for a district of 10,000 population, taking a dry-weather flow of 40 gallons per head per day, and state how you would deal with storm water. Give dimensions wherever possible.
3. A series of settling tanks are to be constructed, each to contain 250,000 gallons. State the dimensions you suggest for one of such tanks, and give sketch, plan and sections showing the form of bottom you suggest, and the position of inlets and outlets, and how same should be formed.

SECTION B. TRAMWAYS CONSTRUCTION.

4. Sketch and describe the various kinds of tramway rail joints in use for electric traction, stating their respective advantages and disadvantages. Design an ordinary fish-plate joint, and point out the features to which you consider special attention should be paid.

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5. Sketch the cross-section of a road 32 ft. wide between kerbs, one side being 1 ft. lower than the other, with double track tramway, 3 ft. 6 in. gauge; show, in figures, the "cambering" of the road, when paved the whole width with stone setts, or Jarrah wood, and also when the tramway is paved with setts, and the remainder of the road macadam.

6. Sketch a "turn out" or "passing place" on a single line of tramway, figure the leading dimensions, the angle of the crossings, and describe the length, position and character of the "points" required for diverting the traffic.

Section C. BRIDGE CONSTRUCTION.

7. Work out the stresses on a wrought-iron girder (sketch given) 56 ft. span 7 ft. high, and give figured sections of flanges, struts and ties. Distributed load 200 tons.

8. State the live load per foot run of paths and carriageway you would allow for in the case of a bridge, 60-ft. span, with a carriageway 36 ft. wide, and 12-ft. paths on each side.

   The bridge has two lines of tramway, 4 ft. 8½ in. gauge, to carry cars weighing 5 tons when loaded, the distance between the two wheel axles being 18 ft.

9. A bridge has to be constructed to carry a 60-ft. street over a canal, the clear span being 40 ft., the minimum head room being 11 ft. at centre and 9 ft. at sides above normal water-level: the approaches are rising gradients of 1 in 24 and 1 in 90 respectively. Sketch the bridge you recommend for such a position, giving all important particulars, short specification tests for materials, and tests for bridge when completed.

Section D. WATER SUPPLY.

10. What percentage of total annual rainfall over a watershed would you expect to have available for storage? State locality and characteristics of the watershed to which your answer relates.

11. A covered reservoir is required to serve a town of 5000 inhabitants. Sketch and describe the reservoir you would adopt, giving all requisite details, and assuming your own conditions of site and foundation. Give a short specification of the necessary works, tests for materials, and an estimate of cost.

12. Sketch and describe a small pumping station capable of lifting daily 100,000 gallons of water from a borehole in the rock and delivering, through a rising main 500 yards long into a reservoir, the total vertical lift being 100 ft. After working out the theoretical horse-power required, state the brake horse-power and type of engine you recommend, and give your reasons.

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II. Subject:—ENGINEERING as applied to Municipal Work.

(Candidates must attempt one question in each section, but not more than six in all.)

SECOND PAPER.

(Time allowed, $3\frac{1}{2}$ hours.)

Section A. GEODESY.

1. Describe the mode of making a land survey with the chain only, and with the usual instruments, and explain the advantages of the latter method. Describe the instruments, and give an illustration of a "field-book" with imaginary entries therein.

2. Make a sketch of the primary and vernier scales of a theodolite for reading to minutes. Explain the object of the vernier, and the principle upon which it works.

3. How would you proceed to contour and make a plan of a valley proposed to be used as an impounding reservoir? What is the advantage of a contour plan for this purpose?

Section B. HYDRAULICS.

4. The velocity in a 9-in. pipe, running full, laid at a gradient of 1 in 48, is 352 ft. per minute. Give the velocities in such a pipe when laid at the following gradients: 1 in 16, 1 in 96, and 1 in 432.

5. A pumping main a mile in length is required to discharge 600 gallons per minute at a velocity of 3 ft. per second. What diameter pipe is necessary?

6. What do you mean by "hydraulic mean depth"? Why is the hydraulic mean depth the same in the case of a circular pipe flowing full or half full, supposing you agree that it is so?

Section C. SEWERAGE.

7. Describe the usual method of setting out the lines for the construction of a sewer, and the means that should be adopted to ensure that the invert shall be laid to the correct depth and gradient.

8. Make a detail sketch with figured dimensions of a storm overflow chamber on a 3 ft. by 2 ft. egg-shaped sewer, discharging when full 600 cubic ft. per minute, assuming that the storm overflow will come into operation when the sewage flowing is one-third the depth of the sewer.

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9. A circular sewer, 4 ft. internal diameter, is to be constructed with brickwork in open cutting, the invert being 15 ft. below the surface of the ground. Trial holes show 6 ft. of loose made ground, 4 ft. of clay, and 12 ft. of running sand resting on a thick bed of clay. Show by sketches the timbering of the trench and the construction of the sewer and give a description of the work and materials.

Section D. ROAD CONSTRUCTION AND MAINTENANCE.

10. Do you consider the stones in macadam should be all of one gauge, or do you prefer varying sizes? State the reasons for your preference.

11. A macadamised carriageway 36 ft. wide has got into bad repair, and the whole surface requires to be recoated with stone for an average thickness of 3 in. Explain in detail the different operations necessary to carry out the repairs, including rolling, and give the cost per yard of each operation, assuming that the cost of the stone delivered on the road is 12*s*. 6*d*. per ton, binding material 3*s*. 6*d*. per ton, and labour 5*d*. per hour.

12. Give a brief description and express your opinion of any methods of road construction and treatment with which you are familiar for the prevention of dust caused by motor traffic.

III. Subject:—BUILDING CONSTRUCTION.

(Candidates must attempt one question in each section, but not more than six in all.)

(*Time allowed, 4 hours.*)

Section A. MATERIALS.

1. State what you know of the various timbers used in building, and what class of work and situation they are each adapted for.

2. State the crushing and safe working loads of any brickwork with which you are acquainted, describing the brickwork.

3. Explain, as far as you can, the different characteristics and chemical composition of common lime, hydraulic lime, Roman cement, Portland cement, and Keene's cement.

Section B. THE CONSTRUCTION OF PUBLIC AND PRIVATE BUILDINGS.

4. A girder, with a clear span of 30 ft., bears a uniformly distributed load of 40 tons; it is supported at one end by a wall and at the other by a hollow cast-iron column, circular in section. The column is 10 ft. in height with fixed ends. Give the dimensions of the column, with method of calculation.

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5. In the construction of a factory chimney specify the following:—
   (a) The subsoil being a stiff clay and weight of shaft 1000 tons, what area of concrete is it necessary to provide for foundation?
   (b) What proportion should the spread of the footings bear to the thickness of the brickwork at the base of the shaft?
   (c) In a shaft 200 ft. high, give the varying thickness of brickwork from base to cap, with distances between the various offsets and height of fire-brick lining.
   (d) What is the usual proportion of the diameter of base to the height of shaft (circular on plan)?
   (e) State the comparative advantages of circular, octagonal and square shafts with regard to wind resistance.
6. Sketch a concrete beam reinforced with steel rods to carry a distributed dead load of 20 tons with a clear span of 15 ft. Show your calculations.

SECTION C. BUILDING BY-LAWS.

7. State how the subsoil of the site of an intended new building should be drained, "where the dampness of the site renders such precaution necessary." Give sketch-plan of drains.
8. Describe fully the chief provisions for the prevention of the spread of fire from one house to another.
9. What information must be given to a sanitary authority by a person desirous of laying out a new street?

SECTION D.—PUBLIC BATHS AND HOSPITALS.

10. Make a cross-sectional sketch of a public swimming bath, 44 ft. in width over all, showing the bath, dressing-boxes, gallery, and roof, with their several dimensions. Describe fully the means adopted for rendering the bath water-tight, and give the type of roof.
11. In designing an isolation hospital for 100 beds, shortly describe the following provisions, viz.:—

    Number and extent of ward blocks.
    Nature of other buildings necessary for administration purposes.
    Proportion of floor space per bed.
    Proportion of cubical space per bed.
    Method of ventilation to be adopted in wards.
    Method of heating to be adopted in wards.

12. In designing public baths, comprising, say, a swimming bath 70 ft. × 30 ft., ten slipper baths, and a small laundry, what method would you adopt to heat the water, and how would you warm the building?

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IV. SUBJECT:—SANITARY SCIENCE AS APPLIED TO TOWNS AND BUILDINGS.

(Candidate must attempt one question in each section, but not more than six in all.)

(*Time allowed, 3 hours.*)

SECTION A. HEATING AND VENTILATION.

1. Explain what you mean by "natural" and "artificial" ventilation. Illustrate your answer by sketches of each as applied to a public building or school. What are the advantages and disadvantages of each system?
2. In preparing a scheme for warming a building, what are the recognised methods of calculating the amount of heating surface required for varying temperatures?
3. Describe concisely three different methods of ventilating sewers, expressing your views as to their merits or otherwise.

SECTION B. SCAVENGING AND DISPOSAL OF REFUSE.

4. Describe the method you would adopt for collecting—
   (*a*) The contents of cesspools.
   (*b*) Excreta in pails.
   (*c*) Offal.

   And give particulars of the vehicle you would recommend in each case.
5. Describe the essential features of a good type of refuse destructor, and give a section of the same.
6. Describe the most satisfactory means of
   (*a*) Removing house refuse,
   (*b*) Cleansing ashpits and privies,

   where the local authority undertake the work of removal.

SECTION C. WATER SUPPLY AND DRAINAGE OF BUILDINGS.

7. Describe the construction of a hot-water service for bath and other purposes in a house. Describe how the circulation is obtained, and show, by a diagram, the position of the boiler, cistern, cylinder, etc., and state the precautions that should be taken to prevent damage by frost.
8. State shortly what are the general principles of efficient house drainage, and give a few examples of how these are frequently disregarded in actual practice.
9. What kind of water acts upon lead? State the risk attendant upon its use and the means you would adopt for avoiding or reducing such risk.

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Section D. DISINFECTION.

10. Mention the various disinfectants in common use, and state which you consider the best for particular purposes. Describe the methods of use and the precautions necessary.

11. What are the points to be observed in the selection of the necessary apparatus to effect the proper disinfection of bedding and clothing? Give a brief description of the apparatus with which you are acquainted.

12. Describe how you would proceed to disinfect a house after the following diseases: (*a*) scarlet fever, (*b*) typhoid fever, (*c*) diphtheria, (*d*) small-pox.

V. Subject:—MUNICIPAL AND LOCAL GOVERNMENT LAW, as relating to the Work of Municipal and County Engineers and Surveyors.

(England)

(Candidates must attempt at least four questions.)
(*Time allowed*, 2 *hours*.)

1. Under what Act can a local authority make by-laws as to deposit of plans for alterations to existing buildings, and to what buildings do these by-laws apply?

2. What are the conditions under which a manufacturer may discharge his trade refuse into the sewers of a local authority?

3. Can a local authority compel a proper supply of water to be laid on to premises, and if so, under what conditions in (*a*) urban districts, (*b*) rural districts? State the mode of procedure in each case.

4. The surveyor to a local authority has reported to him (*a*) a dangerous building abutting on a public highway, and (*b*) a dangerous chimney on private enclosed premises. State what are his powers and duties in each case, and set out fully the proceedings he would take in proper sequence.

5. An occupier refuses to allow his premises to be entered by the assistants of the surveyor to a local authority for the purpose of taking levels: what course is prescribed by statute to meet such a case?

6. State which Acts give powers respecting tramways and light railways, and describe the principal differences between them, particularly as to position of tramway in road, spaces, notices, supervision, and mode of procedure.

7. Describe the provisions of the Buildings in Streets Acts, 1888, and point out in what respect they differ from the previously existing powers.

8. What rights have owners and occupiers of property to connect their drainage with the sewers of a local authority (*a*) within the district, (*b*) without the district? (*c*) under what restrictions can the connections be made? and (*d*) what are the penalties for non-compliance?

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9. Give two instances where you consider the present Public Health and Sanitary Acts or Highways Acts are defective or require amendment, and in what way would you remedy these defects?

This question is intended to elicit answers from candidates as to any difficulties they may have experienced or observed or heard of in carrying out the duties of a surveyor.

10. What is a Provisional Order, and when is it usually applied for? Compare it with a local Act of Parliament, specifying its chief advantages. State the nature of Provisional Orders issued by the Board of Trade as distinct from the Local Government Board.

11. Give reasons for recommending a council to adopt the Private Street Works Act, 1892. State also the disadvantages of that Act compared with sections 150 and 152 of the Public Health Act, 1875.

12. What powers have local authorities with respect to—

(*a*) Planting of trees in highways?
(*b*) Underground conveniences?
(*c*) Sanitary conveniences for manufactories?
(*d*) Ingress to and egress from places of public resort?
(*e*) Safety of platforms on public occasions?

V. MUNICIPAL AND LOCAL GOVERNMENT LAW, AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(Scotland)

(Candidates must attempt at least four questions.)

(*Time allowed, 2 hours.*)

1. Define the various roads to which these words apply, viz., Highway, Turnpike Road, Statute Labour Road, as interpreted by the Roads and Bridges (Scotland) Act, 1878.

2. Describe the statutory provisions whereby a local authority can recover from any person expenses for damage to highways caused by extraordinary traffic thereon, or by excessive weight passing along the same; and state in what Act of Parliament these provisions are embraced.

3. To whom must application be made for authority to lay out new streets? Specify the details which require to be shown on the plan accompanying the application.

4. If a Burgh should desire to improve any existing private streets, what statutory procedure would be necessary?

5. What are the powers of a Burgh with reference to the keeping of footpaths of public streets in proper repair? How far do these powers apply to private streets?

6. Specify the procedure which must be adopted in a Police Burgh before a public sewer can be laid. Under what Act is this necessary?

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7. What powers of entry are given under the Public Health (Scotland) Act for the purpose of examining drains, and what is the necessary procedure?
8. Specify the duty of a Local Authority with reference to the water supply of buildings in an isolated district.
9. Enumerate the powers given for the formation of special water supply districts. State briefly under what circumstances a Local Authority is bound to take action.
10. What were the requirements of the 1892 Burgh Police (Scotland) Act with regard to back space for proposed buildings, and what alteration was made by the 1903 Act?

V. MUNICIPAL AND LOCAL GOVERNMENT LAW, AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(Ireland)

(Candidates must attempt at least four questions.)

(*Time allowed*, 2 *hours*.)

1. What provisions are made under the Public Health (Ireland) Act, 1878 (Section 50), with regard to drains, water-closets, sinks, lavatories, gulley traps, earth closets, privies, ashpits, and cesspools?
2. What extended meaning is given to the word "ashpit" in the Public Health Act of 1890?
3. How would a cesspool require to be constructed to comply with the provisions of the Public Health (Ireland) Act, 1878?
4. By whom, and under what conditions under the Public Health (Ireland) Act, 1878, can—
   (*a*) A drain be connected with a public sewer?
   (*b*) A service pipe be connected with a water main?
5. Under what conditions could a closing Order be obtained for a house or building—
   (*a*) Under the Public Health (Ireland) Act, 1878?
   (*b*) Under the Housing of the Working Classes Act, 1890?
6. What locomotives are exempted by the Locomotives on Highways Act, 1896, from the restrictions of other Public General or Local and Personal Acts in force at the passing of the 1896 Act?
7. Can the jurisdiction of a County Council with regard to roads be transferred to an Urban District Council; if so, what procedure is necessary and under what Act should it be taken?
8. What restriction is there under the Summary Jurisdiction Act as to the distance at which a building can be erected from the centre of a road?

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V. MUNICIPAL AND LOCAL GOVERNMENT LAW, AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS

(Metropolitan)

(Candidates must attempt at least four questions.)

(*Time allowed*, 2 *hours*.)

1. Describe the legal formalities and proceedings incident to and the carrying out of Private Street Works under the provisions of :—
   (*a*) The Metropolis Local Management Act, 1855.
   (*b*) The Metropolis Local Management Act, 1862.
   (*c*) In what important particular does the Metropolis Management Amendment Act, 1890, differ from the last-named statute ?

2. How is a right of light acquired ? Can you name any important decision of the High Courts affecting the matter ? What was established by the House of Lords in the case of *Colls* v. *Home and Colonial Stores, Ltd.* ?

3. Explain the terms, Mis-feasance and Non-feasance. What do the following expressions mean as defined by the Public Health (London) Act, 1891 ?
   (*a*) Trade Refuse.
   (*b*) House Refuse.
   (*c*) Street Refuse.
   (*d*) Rack Rent.
   (*e*) Sanitary Convenience.

   Is the refuse of a restaurant house refuse or trade refuse ?

4. A Metropolitan Borough desires to construct an underground convenience in a public highway. What statutory powers are vested in the local authority to provide such a convenience ? May they use any portion of the public footpath for such a purpose, and do you know of any recent case bearing on the point ?

5. What powers are vested in the London County Council to deal with dangerous buildings ?

6. Explain the difference between a Public and a Private nuisance.

7. What is a combined drain ? Give a definition of " Drain " as applicable to the Metropolis.

8. It is proposed to widen a street in the Metropolis and to acquire the necessary property compulsorily. How is this legally effectuated ? Describe procedure.

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V. COLONIAL LAW, AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(India)

(Candidates must attempt at least four questions.)

(*Time allowed*, 2 *hours*.)

1. Under what circumstances may the local authority lay a sewer without notice?

2. What right of drainage have the owners of any premises—
   (*a*) Into a public sewer,
   (*b*) Into a private drain?

3. Under what circumstances may a Municipality refuse to pay compensation when requiring a building to be set back to improve a street?

4. State the procedure to be followed when an owner proposes to lay out a new street:—
   (*a*) By the Municipality.
   (*b*) By the owner of the land.

5. Describe the action of the Municipality with regard to dangerous buildings—
   (*a*) When the danger is proximate.
   (*b*) When it is imminent.

6. State precisely the difference between the action to be taken when land is likely to be needed, and when it is required for a public purpose.

7. Show circumstances under which the possession of land may be obtained before any award has been made under the Land Acquisition Act.

8. Discuss the matters which may and which may not be taken into consideration when making an award under the Land Acquisition Act.

(BOMBAY CANDIDATES ONLY.)

9. At whose cost is the water service pipe to a house laid and to whom does it belong?

10. Discuss the procedure regarding—
    (*a*) A structure erected to overhang a street.
    (*b*) Placing a stall, ladder, etc., upon any street.
    (*c*) Setting up a scaffold, etc.

11. State the reasons why a building proposal may be disapproved.

12. Are there any provisions of the Municipal Act which, in your opinion, require amendment?

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V. COLONIAL LAW, AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(Africa)

(Candidates must attempt at least four questions.)

(*Time allowed*, 2 *hours.*)

1. Define the terms Dwelling, Drain, Sewer, and Street, as employed in "The Public Health Amendment Act, 1897," and By-laws thereunder.
2. Under what Act or Acts can an Urban Local Authority frame Regulations for regulating and controlling the erection of new buildings?
3. What are the powers of an Urban Local Authority with reference to the regulation and control of the slaughtering of animals for food and the provision of Public Slaughter Houses? State the procedure to be followed in bringing these powers into operation.
4. Several private landowners within the area of a Municipality constituted under the "Municipal Act, 1882," intend selling their land in divided portions or building lots. What are the powers which the Municipality possesses, or can acquire, with reference to ensuring that the plots are of sufficient size, and, generally, that the land and proposed new streets are properly laid out? What procedure should the Municipality follow in bringing their powers into operation?
5. What are the powers of an Urban Local Authority with reference to dwellings which are unsafe or unfit for human habitation? State the procedure to be followed in dealing with such a dwelling.
6. What powers has a Municipality to summarily remove accumulations of filth after short notice to the owner or occupier?
7. What are the borrowing powers :—
   (*a*) Of Municipalities constituted under the "Municipal Act 1882."
   (*b*) Of Boards constituted under the "Villages Management Act, 1881"?
8. A Municipality constituted under the "Municipal Act, 1882," desires to carry out a Sewerage Scheme. Part of the proposed outfall sewer of the proposed site of the disposal works are outside the Municipal area, and the Municipal Council is unable to come to any arrangement with the landowners concerned. What power does the Municipality possess in this connection, and what is the procedure?
9. What enactment entitles an owner or occupier of premises to cause his drains to empty into the sewers of an Urban Local Authority, and what conditions govern the exercise of such powers?

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BOARD OF EXAMINERS.

THE PRESIDENT OF THE INSTITUTION (*ex-officio*).

J. P. BARBER, M. Inst. C.E.
W. NISBET BLAIR, M. Inst. C.E.
J. A. BRODIE, M. Eng., Wh. Sc., M. Inst. C.E.
C. BROWNRIDGE, M. Inst. C.E.
J. BRYCE, M. Inst. C.E.
J. COCKRILL, M. Inst. C.E.
A. E. COLLINS, M. Inst. C.E.
H. A. CUTLER, M. Inst. C.E.
A. T. DAVIS, M. Inst. C.E.
R. H. DORMAN, M. Inst. C.E.
W. DYACK, M. Inst. C.E.
A. D. GREATOREX, M. Inst. C.E.
G. GREEN, M. Inst. C.E.
JAMES LEE.
SIR JAMES LEMON, M.Inst.C.E., F.R.I.B.A.
JOS. LOBLEY, M. Inst. C.E.
C. J. MULVANY, M. Inst. C.E., B.A. I. (Dublin).
JAMES PATON.
J. S. PICKERING, M. Inst. C.E.
W. H. PRESCOTT, M. Inst. C.E., Barrister-at-Law.
R. READ, A.M. Inst. C.E.
O. C. ROBSON, M. Inst. C.E.
H. E. STILGOE, M. Inst. C.E.
R. J. THOMAS, M. Inst. C.E.
H. T. WAKELAM, M. Inst. C.E.
A. E. WHITE, M. Inst. C.E.
C. F. WIKE, M. Inst. C.E.
T. H. YABBICOM, M. Inst. C.E.

CANDIDATES WHO PASSED THE EXAMINATIONS HELD 1912–1913.

76th Examination, October 1912.

W. B. Acton.
H. Anderson.
B. Archer.
R. H. Davis.
F. W. Dean.
G. R. Folland.
H. E. Griffiths.
F. J. Harris.
P. E. Harvey.
J. R. Hill.
F. H. Holden.
E. Pilling.
G. Rigby.
G. Smith.
T. J. Soorma.
G. Stanley.
E. Wickenden.

77th and 78th Examinations, April 1913.

C. G. Atkinson.
F. L. Boydell.
A. Cheyne.
A. Clibbens.
A. Dickinson.
W. Dunbar.
C. Greenwood.
J. W. Hill.
D. Hinchcliffe.
R. E. Holding.
J. Johnson.
H. T. Jones.
F. J. D. Lewis.
W. Metcalfe.
D. R. Morgan.
F. W. Mozley.
W. H. Parham.
S. C. Percival.
W. A. Pover.
W. H. Rean.
P. H. Wakefield.
G. Whitaker.
T. L. Williams.
J Wrest.

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Memoirs of Deceased Members.

THE Council, having been requested to append some short notice of the decease of Members of the Institution, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these "Proceedings."

MR. THOMAS TAYLOR ALLEN, formerly Borough Surveyor of Stratford-on-Avon, died at the ripe old age of 82. He was one of the oldest burgesses of the historic town, and was able to trace his predecessors back to the time of Shakespeare. Tablets to ten of his family predecessors are to be seen on the north transept walls of the old church. Mr. Taylor was articled to the late Alderman Edward Gibbs, Surveyor, and continued in his employ for several years. He then commenced business on his own account, and for 44 years carried on a large architectural practice. He was Surveyor to the Local Board of Health, and afterwards Borough Surveyor for a further term of years. In addition to being Borough Surveyor, he was appointed as the first Surveyor to the newly formed Highway Board having the control of 96 miles of roads in 21 different parishes. After his retirement from active business life Mr. Allen was placed by the burgesses of the Guild Ward at the head of the poll, and served the town as Councillor for the term of 18 years.

Mr. Allen was one of the founders of the Institution, his election dating from May, 1873.

MR. GEORGE WILLIAM HEWES, Surveyor to the Barrowford Urban District Council, died on May 24, 1913, at the age of 38.

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He was taken ill the previous Sunday, being removed to the Manchester Infirmary on the Thursday where an operation was performed, but, despite every care and medical skill, he passed away, the end being due to peritonitis.

Mr. Hewes was born in London, going to Burnley in 1886. At a later date he was appointed Sanitary Inspector to the Burnley Rural District Council. Whilst holding this position Mr. Hewes proved himself a very painstaking and capable official, and assiduously strove to add to his professional qualification; he obtained the Testamur of the Institution of Municipal and County Engineers in 1906. In 1909 he was appointed Surveyor and Sanitary Inspector to the Barrowford U.D.C., where he carried out several schemes of importance, receiving on more than one occasion the congratulations of the Local Government Inspector, during the local inquiry. At the time of his death Mr. Hewes had just completed and deposited with the Local Government Board, complete plans, etc., for the alteration of the existing Sewage Disposal Works.

Mr. Hewes joined the Institution as a Graduate in June, 1906, and was transferred to the class of Members in February, 1912.

MR. JOHN GABRIEL O'SULLIVAN died on December 25, 1912, in his 45th year. He had been for some 22 years in the service of the Dublin Corporation. He was appointed in 1901 Deputy Borough Surveyor, and in 1910 he succeeded Mr. Spencer Harty as Borough Surveyor. He designed and carried out the construction of the large supplemental reservoir at Roundwood, Co. Wicklow, at a cost of over 100,000*l.*, and other important municipal works. He was originally in the Government service as Assistant Engineer.

Mr. O'Sullivan was elected a Member of the Institution in December, 1910.

MR. JONAS PROCTOR died at Bolton on October 9, 1912, aged 71. In 1866 he was appointed Borough Surveyor of Bolton, and retained that office for 18 years, carrying out extensive municipal improvements. He then took up consulting practice, and in 1887 became one of the owners of the Behive Engineering Works. In 1895 he established the firm of

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Jonas Proctor & Sons, Ltd., of Moses Gate Machine Works, and directed the business until his death.

Mr. Proctor was one of the founders of this Institution, his election dating from May, 1873.

MR. FREDERIC WILLIAM RICHARDSON, formerly Surveyor of Aston Manor, was born on February 3, 1877, and died at Sidmouth on October 23, 1912. Mr. Richardson served his articles with his brother, Mr. Harry Richardson, and became assistant to Mr. G. H. Jack of Aston, whom he succeeded. When Aston was absorbed by the City, Mr. Richardson was offered a post under the Birmingham Corporation, but declining this offer, he accepted his pension in compensation of loss of office, and going to London set up in private practice. Here his health failed, and he was ordered to live in the South. The insidious disease from which he was suffering developed rapidly, and he died, as stated, at Sidmouth, where he had taken up his abode. He was interred at Handsworth Old Church.

Mr. Richardson was elected a Member of the Institution in July, 1908.

MR. JOHN ROBB, County Road Surveyor of Mid-Lothian, died at Edinburgh, in the 50th year of his age. Mr. Robb, after serving his apprenticeship in an architect's office in Alloa, took up an appointment at Edinburgh in the offices of the assessor for railways and canals. He some time after entered the service of the Mid-Lothian County Council as Suburban District Surveyor, which post he held till 1896, when he succeeded the late Mr. Forbes as County Road Surveyor. With the increase of motor traffic, a great deal of work was required in order to bring the roads up to modern requirements, and into his work he brought many progressive ideas, and last autumn he was complimented by the Road Board representatives, who were making their annual road inspection, on the way in which the two grants of 6000*l*. and 5000*l*. had been expended. At the time of his death he was engaged in the preparation of plans for the new bridge over the Water of Leith and the Caledonian Railway line at Colinton.

Mr. Robb joined the Institution as an Affiliated Member in January, 1912.

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MR. WILLIAM PAGE ROBINSON, late Surveyor of the Skelton and Brotton Urban District Council, an office which he held for over twenty years, died November 1, 1912.

Mr. Robinson was elected a Member in October, 1891.

MR. WILLIAM SMITH SHELL, late Surveyor to the Consett Urban District Council, was born on June 24, 1857, and died in October, 1912. Mr. Shell served his pupilage under Messrs. John Smith & Son, Architects and Surveyors, and was for some time assistant to the senior partner, who was Surveyor to the Benfieldside Local Board. He was appointed Surveyor to the Consett Urban District Council in June, 1898.

Mr. Shell was elected a Member of the Institution in June, 1905.

MR. JAMES SMITH, late Borough Surveyor of Buckingham, died on April 19, 1912, in the 43rd year of his age. Mr. Smith commenced his professional career in the Surveyor's office at Hackney, and in October, 1893, was appointed Borough Surveyor of Buckingham. He assisted in carrying through the Sewerage and Water Schemes, the Isolation Hospital, the improvement in the Market sites in the High Street, and many other municipal works. He carried out great improvements in the roads in his district. Some years back he suffered from an attack of rheumatic fever which left an affection of the heart from which he never recovered. He left a wife and eight children.

Mr. Smith was elected a Member of the Institution in May, 1897.

MR. WILLIAM WEAVER was born in February, 1844, and saw early service as an articled pupil to the then Surveyor of Kensington, the late James Broadbridge, in 1860. He eventually succeeded to the position of Assistant Surveyor, and became Borough Surveyor in 1875. He was connected with the Royal borough for a period of forty-three years, and his professional record was synonymous with the development of the district from a pastoral suburb into one of the most fashionable parts of London. Mr. Weaver was responsible for, and superintended most of the municipal schemes that tended so much to the improvement of Kensington. As an expert on municipal work and law, his evidence before the Committees of the

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Houses of Parliament, or in courts of law, carried considerable weight, as the practical experience of a man who has devoted the whole of his working life to metropolitan work. Common-sense and thoughtfulness were his conspicuous qualities, yet his speeches were marked by humorous flashes which contributed to their attractiveness as well as their interest.

Mr. Weaver was elected a Member of the Institution in June, 1887, and was president 1903–04.

THE HONOURABLE PERCIVAL ROBERT AUGUSTUS WILLOUGHBY, M.Inst.C.E., Director of Public Works of the Island of Jamaica, died on May 1, 1913, at Towy Villa, Llandilo, Carmarthenshire. He was born on May 14, 1868, and was educated at Merchant Taylor's School, and afterwards (1885 to 1887) attended the Engineering Course at University College, London. He was articled to Mr. H. C. Fisher, M.Inst.C.E., of Cardiff, engineer of the Taff Vale Railway Company, during which time he was engaged on the construction of new works, also on the general maintenance of the railway of that company and their Penarth Dock and Harbour. On the completion of his pupilage he proceeded in 1889 to India, where he obtained an appointment under the Dooars Tea Company, Bengal, as executive engineer. When there he was engaged on the construction of roads, bridges, bunds, impounding reservoirs for water power, the erection of buildings and machinery, together with the management of a large labour force. In 1891 he returned to England and was employed for a short time on the engineering staff of the Taff Vale Railway Company, during which time he made a series of new sections of the whole of the Company's railways.

In 1891 he secured an appointment as an assistant on the staff of Mr. William Harpur, M.Inst.C.E., the City Engineer of Cardiff, where he remained until 1895, being engaged on extensive public and private improvements, bridge widenings, etc. In 1895, he was appointed Deputy Engineer to the Merthyr Corporation, which position he held until 1898. He designed and carried out whilst there extensive drainage schemes, public improvements, road widenings, etc. In 1898, he became Civil Engineer to the Dowlais Iron Company. Whilst at Dowlais he had the control of all classes of labour, and was engaged in the design, construction, and maintenance of

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the roads, railroads, culverts, buildings and property of the Company. He remained at Dowlais until 1903, when he was selected by the Pontypridd Urban District Council as their engineer and surveyor, which appointment he held for about six years, 1903–1909. On December 24, 1908, he was appointed Director of Public Works, Jamaica. At the outset he was confronted with the devastation resulting from the disastrous earthquake and fire of less than two years before, and Kingston was more or less in ruins. He devoted all his energies to the reinstating of the damage done, and under his *régime* the new Kingston was laid out and rebuilt. During the period he actively directed affairs the Public Works Department spent something over 150,000*l*. in improving roads, making new roads, etc. He designed and carried out several important new works, amongst them the new bridge across the Johnson River St. Thomas, of sixteen spans and a total length of about 800 feet, in ferro-concrete, and the improvement of the water supply of Spanish Town by means of hydraulic rams. When home he became unwell, and after consulting eminent medical men it was considered imperative that he should undergo an operation from which he did not recover.

He was elected a Member of this Institution on October 29, 1904.

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INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS' ORPHAN FUND.

LIST OF COMMITTEE AND OFFICERS, 1912–13.

Committee:

MR. R. J. THOMAS (President).
MR. J. PATTEN BARBER.
MR. W. NISBET BLAIR.
MR. A. H. CAMPBELL.
MR. J. W. COCKRILL.
MR. C. H. COOPER.
MR. W. HARPUR.
MR. E. PURNELL HOOLEY.
MR. C. JONES.
MR. W. H. LEETE.
MR. H. RICHARDSON.
MR. E. WILLIS.

Trustees:

MR. O. CLAUDE ROBSON.
MR. S. STALLARD.
MR. T. H. YABBICOM.

Hon. Secretary and Hon. Treasurer:

MR. O. CLAUDE ROBSON,
Municipal Offices,
Dyne Road, Kilburn, N.W.

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INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS' ORPHAN FUND.

July 16, 1913.

To the Subscribers to the Orphan Fund of the Institution of Municipal and County Engineers.

GENTLEMEN,

Your Committee are pleased to report that the interest in the Fund as evinced by the Members of the Institution in previous years has been more than maintained during the year 1912, the number of subscribers being 201 as compared to 140 during the preceding year, whilst the income derivable from subscriptions and donations has been 157*l*. 5*s*. 9*d*., or 29*l*. 0*s*. 9*d*. in excess of the subscriptions and donations received during the year 1911. Although the proportion of increased income is less than the proportionate increase in the number of subscribers, it is most gratifying to find that a larger number of the Members of the Institution are taking an interest in the work of the Fund.

This addition to the muster roll of subscriptions is largely due to the energy which Mr. Hooley, the County Surveyor of Nottingham, has characteristically thrown into the work of the Fund by appeal to his colleagues in the East Midland District, the result being that the subscription list of that particular district has been four times that of previous years. Your Committee are of opinion that the thanks of this meeting are due to Mr. Hooley for the assistance he has rendered, and is always willing to render, to the Fund for the benefit of the Orphans of deceased Members.

The amount of grants made during the year has been 120*l*., the number of children benefited being 20, whilst one child in addition is being educated at the British Orphan Asylum, by means of a presentation which was purchased in 1909.

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It is gratifying to be able to record that in no single instance has it been found necessary to refuse an application for a grant where the subject of same comes within the rules of the Fund.

The death of Mr. John Eayrs in May, 1912, necessitated the appointment of a new trustee. Mr. Sidney Stallard, the County Surveyor of Oxford, being unanimously chosen to fill the vacancy. This has involved the whole of the invested stock being transferred to the names of the three present trustees, who are as follows:—

Thomas Henry Yabbicom,
Oliver Claude Robson,
Sidney Stallard.

Your Committee have with regret to record the death of Mr. Lewis Angell, the first President of the Institution, and a Member of the Orphan Fund Committee since its inauguration in 1899. The vacancy upon the Committee thus caused was filled by the election of Mr. H. Richardson, a gentleman who has at all times given great assistance in furthering the objects of the Fund.

The balance sheet for the year may be considered as satisfactory in every respect, the subscriptions having been thoroughly maintained in amount as before stated, and a balance of 180*l.* 10*s.* 3*d.* appears at the end of the year 1912. This balance would, however, have been reduced had it been possible to invest a portion of same as instructed during the year to which this report refers, but owing to the transfer of securities occasioned by the death of Mr. Eayrs it was found impossible to effect the investment of any of the surplus monies of the Fund until February, 1913.

The total amount invested in Trustee Stock on December 31, 1912, was, according to the market value at that date, 998*l.* 15*s.* 10*d.*, the income derivable from same having been 33*l.* 18*s.*

Details in connection with the accounts of the Fund are shown upon balance sheet herewith appended, and which has been duly certified as correct by the Auditors of the Institution, Messrs. Wood, Drew & Co., of 139 Cannon Street, E.C.

The question as to the desirability of securing the right to an additional Presentation from an Orphan Asylum has been duly considered by your Committee, and your Honorary Secretary has been instructed to make inquiries of various Institutions as

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CASH ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1912.

Dr.	£	s.	d.	*Cr.*	£	s.	d.
Balance brought forward, January 1, 1912	120	1	1	Grants to Orphans	120	0	0
Donations	28	14	9	Printing Rules and Regulations, etc., Postages, and Sundries	10	14	7
Subscriptions	128	11	0	Balance	180	10	3
Interest on £148 Portsmouth Corporation 3½ per cent. Stock	4	17	8				
Interest on £232 L. & N. W. Rly. 3 per cent. Debenture Stock	6	11	0				
Interest on £100 West Ham Corporation 3½ per cent. Stock	3	1	4				
Interest on £264 15s. 4d. Consols, 2½ per cent. ..	6	4	8				
Interest on £465 14s. 10d. London County 3 per cent. Stock	13	3	4				
Total	£311	4	10	Total	£311	4	10

GROSS ASSETS.

	£	s.	d.
Balance on Current Account	180	10	3
London and North-Western Railway Stock	189	1	7
Portsmouth Corporation Stock	143	11	2
West Ham Corporation Stock	90	0	0
Consols	198	18	1
London County Stock	377	5	0
Total	£1179	6	1

Examined and approved.

WOOD, DREW & CO.,
Chartered Accountants.

London, 130 Cannon Street, E.C., May 30, 1913.

to the cost and advisability of purchase of this form of entrance into a recognised Institution of repute. The advantage or otherwise of dispensing the Funds in this direction will be duly considered, but from opinions received from some of the Grantees of the Fund it appears to your Committee that the annual amounts now paid to the widows on behalf of the orphans of deceased Members are more appreciated than the possible schooling and consequent separation of one child from the family. A further report will, however, be made to the Committee upon this matter, upon receipt of additional information from the Hon. Secretary.

The list of Subscribers to the Fund is herewith appended, and it will be noted that a departure has been made from the usual custom of recording the names of the subscribers in one list in alphabetical order, the subscribers and donors now being separated according to the various districts representing the administrative areas in connection with the Institution of Municipal and County Engineers.

The outgoing Members of the Committee during the year were Messrs. Cockrill, Hooley, Jones, and Willis, who were duly re-elected at the General Meeting held at the Caxton Hall, Westminster, on July 11, 1912.

Before concluding this report your Committee would like to express their great thanks to many of the various district representatives of the Institution, who have interested themselves in the welfare of the Fund by endeavouring to secure subscriptions during the year 1912. It is sincerely hoped that the additional interest thus shown by the district representatives will result in a very considerable addition to the roll of subscribers in the ensuing year.

R. J. THOMAS,
Chairman

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INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS' ORPHAN FUND.

List of Donations and Subscriptions for the Year ended December 31, 1912.

Name.	Donation.	Annual Subscription.	Total Contribution.
East Midland District.			
	£ s. d.	£ s. d.	£ s. d.
Anon	0 5 0		5 0
Baldwin, L. L., Coalville		0 10 0	0 10 0
Baxter, J. G. R., Grimsby		0 2 6	0 2 6
Bennett, E. H., Derby		0 5 0	0 5 0
Brown, A., Nottingham		1 1 0	1 1 0
Brown, C. F., Gainsborough		0 2 6	0 2 6
Burn, W., Sutton-in-Ashfield		0 5 0	0 5 0
Clare, J., Sleaford		0 5 0	0 5 0
Clare, S. F., Sleaford		0 1 0	0 1 0
Clark, W. G. J., Wigston Magna ..		0 2 6	0 2 6
Clarke, G. E., Boston	0 10 0		0 10 0
Clarke, R. E., Arnold		0 5 0	0 5 0
Clews, C. A., Derby		0 10 0	0 10 0
Coales, H. G., Market Harborough ..		0 10 6	0 10 6
Collinge, T. P., Mansfield		0 10 6	0 10 6
Cook, F. P., Mansfield Woodhouse ..		1 1 0	1 1 0
Cordon, R. C., Belper		0 5 0	0 5 0
Court, W. H. A., Leicester		0 2 6	0 2 6
Crump, E. H., Hinckley		0 10 6	0 10 6
Elliott, A. H., Nottingham		0 7 6	0 7 6
Fenn, T., Belper		0 2 6	0 2 6
Frank, T. Pierson, Newark		0 10 6	0 10 6
Garratt, C. T., Leicester		0 5 0	0 5 0
Gordon, T. W., Nottingham		0 5 0	0 5 0
Gray, C. C., Scunthorpe		0 2 6	0 2 6
Haller, J. C., Carlton		0 10 6	0 10 6
Harrison, W. A., Long Eaton		0 2 6	0 2 6
Haseldine, W. S. T., Answorth		0 5 0	0 5 0
Hawley, G. W., Nottingham		0 10 6	0 10 6
Heap, H., Great Grimsby		0 2 6	0 2 6
Henry, T., East Retford		0 5 0	0 5 0
Hodson, C. F., Lincoln		0 5 0	0 5 0
Hooley, E. Purnell, Nottingham ..		1 1 0	1 1 0
Hopkinson, F., Worksop		1 1 0	1 1 0
Horton, J. W., Derby		0 10 6	0 10 6

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Name.	Donation. £ s. d.	Annual Subscription. £ s. d.	Total Contribution. £ s. d.
Jaffrey, W., Matlock		0 5 0	0 5 0
Kennedy, J. D., Retford		0 5 0	0 5 0
Lake, T., Bourne		0 5 0	0 5 0
MacBrair, R. A., Lincoln		0 10 6	0 10 6
Mason, S., Grimsby		0 2 6	0 2 6
Mawbey, E. G., Leicester		1 1 0	1 1 0
Maylan, S., Basford		0 10 6	0 10 6
Oakden, R. (junr.), Newark		0 10 6	0 10 6
Parker, S. W., Gainsborough		0 10 6	0 10 6
Peacock, T. J., Spalding		0 5 0	0 5 0
Pick, S. P., Leicester	1 1 0		1 1 0
Purser, W. B., Grantham		0 10 0	0 10 0
Rawson, G., Worksop	0 10 6	0 10 6	1 1 0
Ryman, F. R., Stamford		0 10 6	0 10 6
Silcock, H., Mansfield		0 10 6	0 10 6
Thomas, W. N., Nottingham		0 2 6	0 2 6
Tonge, J. A., Mansfield		0 5 0	0 5 0
Ward, J., Derby		1 1 0	1 1 0
Whyatt, H. G., Grimsby		1 1 0	1 1 0
Wright, F. W., Ilkeston		0 5 0	0 5 0
Wright, W., Grantham		0 5 0	0 5 0
Collection at Ilkeston Meeting: Per Mr. R. A. MacBrair	4 8 0		4 8 0

Eastern District.

Barrett, E. J., Staines		0 10 6	0 10 6
Blackwall, J. E., Cambridge		1 1 0	1 1 0
Brown, R., Southall-Norwood		0 10 6	0 10 6
Coales, H. F., Sunbury-on-Thames ..		0 5 0	0 5 0
Cockrill, J. W., Great Yarmouth ..		1 1 0	1 1 0
Collins, A. E., Norwich		1 1 0	1 1 0
Collis-Adamson, A. C., Highgate ..		0 5 0	0 5 0
Cooper, L. A., Chiswick		0 10 6	0 10 6
Croxford, C. H., Wood Green		0 5 0	0 5 0
Croxford, J. W., Brentford		0 5 0	0 5 0
Dunn, J., Cambridge		0 10 6	0 10 6
Elford, E. J., Southend-on-Sea		1 1 0	1 1 0
Farrington, W., Woodford		1 1 0	1 1 0
Gladwell, A., Slough		1 1 0	1 1 0
Goodyear, H., Colchester		0 5 0	0 5 0
James, A. C., Grays		1 1 0	1 1 0
Jenkin, C. J., Finchley		0 10 6	0 10 6
Jones, C., Ealing		1 1 0	1 1 0
Julian, J., Cambridge		0 5 0	0 5 0
Leete, W. H., Bedford		1 1 0	1 1 0
Lovegrove, E. J., Hornsey		1 1 0	1 1 0
Robson, O. C., Willesden		1 1 0	1 1 0
Savage, W. H., Cockfosters		1 1 0	1 1 0
Smith, F. Hall, Sheringham		0 5 0	0 5 0
Thomas, R. J., Aylesbury		1 1 0	1 1 0

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Name.	Donation. £ s. d.	Annual Subscription. £ s. d.	Total Contribution. £ s. d.
Webb, J. A., Great Stanmore		0 10 6	0 10 6
Willis, E., Chiswick		1 1 0	1 1 0
Collection at Lowestoft Meeting: Per Mr. E. J. Elford	1 15 0		1 15 0

West Midland District.

Butt, E. E. W., Birmingham		0 5 0	0 5 0
Clarry, W. A. H., Sutton Coldfield ..		0 10 6	0 10 6
Clarson, H. J., Tamworth		0 5 0	0 5 0
Coleby, H. J., Atherstone		0 5 0	0 5 0
Cook, F. C., Nuneaton		0 10 6	0 10 6
Currall, A. E., Solihull		0 10 6	0 10 6
Davis, A. T., Shrewsbury		1 1 0	1 1 0
Douglas, S., Kenilworth		0 10 6	0 10 6
Fiddian, W., Stourbridge		1 1 0	1 1 0
Gettings, C. F., Worcester		0 10 6	0 10 6
Greatorex, A. D., West Bromwich ..		1 1 0	1 1 0
Green, G., Wolverhampton		1 1 0	1 1 0
Jack, G. H., Hereford		0 10 6	0 10 6
Lacey, G. W., Oswestry		0 10 6	0 10 6
Perkins, J., Birmingham		0 5 0	0 5 0
Ransom, W., Worcester		0 2 6	0 2 6
Richardson, H., Birmingham		0 10 6	0 10 6
Rogers, W. E., Rugeley		0 10 6	0 10 6
Shipton, T. H., Oldbury		0 5 0	0 5 0
Stilgoe, H. E., Birmingham		1 1 0	1 1 0
Watson, J. D., Birmingham		1 1 0	1 1 0
Willcox, J. E., Birmingham		1 1 0	1 1 0
Willmot, J., Birmingham		1 1 0	1 1 0
Woodward, F., Stourbridge		0 10 6	0 10 6
Collection at Stourbridge Meeting ..	2 9 9		2 9 9
Balance of expenses, ditto .. .. Per Mr. F. Woodward	0 8 0		0 8 0

Metropolitan District.

Barber, J. P., Islington		1 1 0	1 1 0
Blair, W. N., St. Pancras		1 1 0	1 1 0
Boulnois, H. Percy, Westminster ..		1 1 0	1 1 0
Cole, T., Westminster		1 1 0	1 1 0
Finch, A. R., Kensington		1 1 0	1 1 0
Giles, H. A., Westminster		0 5 0	0 5 0
Hayward, T. W. A., Battersea		1 1 0	1 1 0
Higgens, T. W. E., Chelsea		1 1 0	1 1 0
Humphreys, G. W., London C.C. ..	1 1 0		1 1 0
Killick, P. G., Finsbury		1 1 0	1 1 0
Moss-Flower, T. J., Westminster ..		1 1 0	1 1 0

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Name.	Donation	Annual Subscription.	Total Contribution.
	£ s. d.	£ s. d.	£ s. d.
Silcock, E. J., Westminster		2 2 0	2 2 0
Sumner, F., City Corporation		1 1 0	1 1 0
Van Putten, E., Catford		1 1 0	1 1 0
Weaver, W., Putney Hill..		0 10 6	0 10 6
Willcocks, G. Waller, Roehampton ..		1 1 0	1 1 0
Winter, O. E., Hampstead		0 10 6	0 10 6

North-Eastern District.

Beaumont, A., Beverley		1 1 0	1 1 0
Beaumont, G. E., Grenoside		1 1 0	1 1 0
Dennis, N. F., West Hartlepool		0 10 6	0 10 6
Dickinson, R., Berwick-on-Tweed ..		0 5 0	0 5 0
Drew, J. H., Wath-on-Dearne		0 10 6	0 10 6
Hadfield, W. J., Sheffield		1 1 0	1 1 0
Hart, G. A., Leeds		0 10 6	0 10 6
Lancashire, W. T., Leeds		1 1 0	1 1 0
Massie, F., Wakefield		1 1 0	1 1 0
Wike, C. F., Sheffield		1 1 0	1 1 0
Wrigley, G. E., Sowerby Bridge ...		0 5 0	0 5 0
Collection at Bridlington Meeting:			
Per Mr. J. P. Wakeford	3 8 6		3 8 6

North-Western District.

Brodie, J. A., Liverpool		1 1 0	1 1 0
Brodie, J. S., Blackpool		1 1 0	1 1 0
Diver, D. J., Marple		0 10 6	0 10 6
Heath, J., Urmston		0 5 0	0 5 0
Hellawell, O., Withington		0 10 6	0 10 6
Meade, T. de Courcy, Manchester ..		1 1 0	1 1 0
Platt, S. S., Rochdale		1 1 0	1 1 0
Price, A. J., Lytham		0 10 6	0 10 6
Stubbs, W., Blackburn		0 10 6	0 10 6
Travers, W. H., Wallasey		0 10 6	0 10 6
Wilding, J., Runcorn		0 10 6	0 10 6
Wiles, J. W., Manchester		0 10 6	0 10 6
Wolfenden, B. J., Bootle		0 10 6	0 10 6
Worrall, E., Manchester		1 1 0	1 1 0

Southern District.

Frost, H., Gosport		0 10 6	0 10 6
Guilbert, T. J., Guernsey		1 0 6	1 0 6
Hawkins, J. F., Reading		1 1 0	1 1 0
Jones, Lt.-Col. A. S., Finchampstead ..		1 1 0	1 1 0
Lemon, Sir J., Southampton		1 1 0	1 1 0

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